**AUDIENCE:** The light comes from the bulb. And it goes into the mirror, and it bounces over to the paper. So that's how you can see the reflection of the words on the paper.

**PROFESSOR:** OK. Very nice. So in astronomy, whenever we're dealing with something making images, which we're going to use telescopes to make images. We're also going to use cameras to make images, there's always three important parts.

One is the source of light, whether that's a star or a planet or a light bulb or something that produces light. You also have to have a reflector, or a mirror, that takes that light, reflects it, but also focuses the light, kind of pulls it together. And then that is the light bounces off the reflector and then goes to the detector.

So I'm going to hold this up for you. This is your detector, right? And the reason that we put all these little squares on it is because real detectors, which we call CCDs or charge coupled devices, are really little pieces of silicon which have a bunch of these little squares kind of drawn on them.

Silicon is an element, and it's particularly sensitive to light. And so we're going to see that in a real telescope when light hits a particular place on this detector, the detector records where the light came in. Just like what you did here. You made the image project over here.

So everybody kind of gathers around. I do have-- and Peter if you could pull up the close up image of the detector. Maybe put it up there. I want everybody to come over here to table three, or table four. Four, I'm sorry. And I have an actual CCD that was on the back of some of the telescopes, and I'll let you guys just take it.

Can we turn the lights up? This is actually one of the CCDs from the telescopes that we're going to use. We're going to use some visible light telescopes. If you look really closely, can you see the little tiny squares? What do you think? They're pretty small, right? They're actually-- what's that?

**AUDIENCE:** Is that nanotechnology?

**PROFESSOR:** Not quite. So these squares are a couple of micro-- not micrometers. Are they micrometers? I think they are a couple of microns. So they are a couple of millionths of an inch across. So they're very, very small. So you can't really see that. But if you look up on the board, yeah I guess you have to go kind of closer to the screen.

Take a look at the screen. On the bottom half, this is the edge of one of those detectors. On the top half, that's the actual detector part. So what happened with this detector was the bottom part kind of short circuited, and it blew out, which is why you see the weird kind of stuff there. But if you look right up here, what do you see if we've zoomed in a lot?

[INTERPOSING VOICES]

Some yellow stuff, what shape? They look like little squares. So on that little tiny thing that's, like, a few millimeters by a few millimeters, instead of having a big detector like you had, like 8 1/2 by 11 inches, most astronomical telescopes focus their light down onto a tiny little chip. And each one of those squares is sensitive to light. And that's how we detect light and we make it into an image.

We're going to talk a little bit more about this process, but I just wanted you to be a little bit familiar with the idea of projecting an image and then projecting it to a certain place in space, like we're going to project onto that small piece of silicon. So what we're going to do now is we're actually going to use some images to learn about sizes.

So we need you to take your notes, and I want you to head back over to your computer table. What did we decide were the important quantities that helped us decide what size or what width something looked in the image? What can we change when we take pictures of something to make to make Mars or to make the guy in the tire look a different size? What are important quantities? Go ahead Bianca. Nice and loud.

**AUDIENCE:** Perspective.

**PROFESSOR:** Perspective. OK. What does that have to do with?

**AUDIENCE:** Where you're taking the picture.

**PROFESSOR:** Where you're taking the picture. So David?

**AUDIENCE:** [INAUDIBLE]

**PROFESSOR:** OK, go ahead.

**AUDIENCE:** Magnification.

**PROFESSOR:** OK. So magnification. We're not going to use the zoom on our camera, so we're actually not going to deal with that for right now. We're just taking the picture. So as [INAUDIBLE] said, perspective. What does that mean?

**AUDIENCE:** Different angles.

**PROFESSOR:** OK. Different angles. So we could take a picture from the side or from the front. [? Lauren, ?] you had your hand up?

**AUDIENCE:** I was gonna say distance is important.

**PROFESSOR:** OK. Is distance important? OK. What does distance have to do with perspective?

**AUDIENCE:** Closer you-- the closer you are, the larger something appears.

**PROFESSOR:** OK. So the distance from your detector or your camera to the object. Here, we said the tire is closer to the camera. There, you said the car is closer to the camera. Here, we said the-- well there, we said the sun is bigger than it really is, right? So you've got the distance to the object, but what is something else that affects how something looks in an image? Go ahead, Nikki.

**AUDIENCE:** The right position that you're in, I guess it matters.

**PROFESSOR:** OK. The position of the object or the relative position between the two objects. Yeah. So it matters, in this case, if we're looking at two different objects, it's the distance to both of the objects that makes a difference.

We're actually going to just have you look at the distance to one object here in a minute, just to make it a little bit simpler, right? But what else is important? Did you have your hand up, [INAUDIBLE]? Go ahead, Chris.

**AUDIENCE:** The actual size of something?

**PROFESSOR:** OK. The actual size of something. We said if we put the toy car that has a small actual size-- or let's just say actual length of the car. If we put the toy car close, it looks like it's the same length as the car that's farther away.

So those two things are really important. How far away something is, the distance to the object, And the actual width of the object or the actual height of the object. You have to match those up to make sure that you're getting things to look the same. So.