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[00:00:00.00] Evan: I think that they're right now, that we're at a point where that's a question we can start to ask in the next two days okay because tomorrow's challenge is very very different than what we did today
Jess: yeah
[00:00:16.20] Katey: so when you say, what they should be getting out of the iterations do you mean like,
Jess: Like are they, I guess are they reflecting enough when they fail? Like, do they understand? Are they thinking about, "okay why did this fail? What can I do to improve it?" or are they just going, "Oh, doesn't work, let's try something else"?
[00:00:37.06] Evan: [7 second pause] and that's okay
Jess: Yeah
Evan: and that they have they have to come to a degree of comfort they're (whispers)
K: I don't know if they the like the
So in the group over there one girl was talking about how in the first one, in the first version with the unlimited amounts of materials they weren't starting over every time they were adding every time, so when they got to the second thing they had to be a lot more uh, what's the word, not cautious but a lot more strategic because they needed to not--they wouldn't be able to just add on. So we, I was thinking about that same kind of question, like, is it really an iteration if you just add on or is that a version of a optimization?
Jess; you could ju--
K: I think it's okay...
Jess: yeah
[00:01:38.28] Felicity: most of the people at the table I was at said that they had to rebuild the whole thing because you know they were using marshmallows and sticking them in everywhere the only thing was they did say that they could reuse the base. On some of them they used the same base.
Ricardo: At our discussion, the kids said, a second part they felt they were more limited, they had the constraints, but at the same time they were more focused because they already knew exactly what they were doing they were not really so much focused the first time but the second part they had more limitations, but they knew better what they had to do.
K: Yeah
E: Well, this is you know when you look at the learning stuff, nearly every one of them had string and tape left over. K?
K: mmhmm
E: String and tape left over.
K: Collectors [?]
E: ok?
K: Yeah

E: So, they didn't learn a lot about string, or they didn't learn a lot about tape. Ok? Because a lot of these things would been a lot taller, from an engineering perspective [genstures to Jess], had they used a little bit of tape as a structural member in order to increase the strength and the dynamic strain on some of these things. All's you had to do is put a piece of tape [gestures] where your under tension, and everything becomes, um, much easier to deal with.
How many of you saw two feet of tape sitting on a table
K: yeah
E: M-kay, so in terms of the whole process, if you, if we had said, in the thing, "you have [emphasis] to use 39cm of tape and [emphasis] you have to use 39 cm string and [emphasis] you have to use 20. All of those things have to be utilized", we would have seen a very very different construction.
[00:03:47.19]
K: I'm not sure that they all would have gotten that tension thing though automatically
E: well, no no
J: Well this is I guess, I don't know, if you made it into an engineering project you could add like a tape lab where they must use ____ tape or something.
E: yeah
K: I think, yeah, I think one thing one thing I struggled with with all of this is like; yeah I'd love them to get that
E: right but I'm saying is, the way that you tell them to construct it produces a very different outcome.
K: I think some kids would have just wrapped tape around spaghetti more, I don't think they would have
E: And you know what?
K: they would have not
E: They would have been able to make the towers considerably taller
[00:04:26.26]
K: right, ok, yeah
E: Do you see what I'm saying?
K: you're still not learning like, any brand new... they're not learning new like, truss support, like
E: No no no, but even using the tape efficiently to laminate the the spaghetti so that by putting two pieces together doesn't make the beam twice as strong. Ok? It's not just doubling the strength, it's sat, it's I mean, otherwise we wouldn't laminate things because everything has a different... the way materials go together, so if they had used the tape in the centers, that would have increased the strength of each of those things. So when you watch these kids they were putting, they were taping the two pieces together to make em longer, using them as a junction, rather than a structural member.
And so, what I'm saying is, is if they had started having to decide where to put that tape on those things they would have found that they could use less material and made things much bigger and longer and made much lar--wider stuff and they could have used the string to support the =-as these things started to bow out.
Did you see the one group that was in the first iteration?

J: That had like the weaving
E: That had the weaving and then there was one group that took and put a hole through the marshmallow, and then tied the string down through the marshmallow so that it gave it
And put the whole thing under tension and taped it down they were--they tried that. And you know, interesting idea
K: Mmhmm
E: SO the way you present the problem eh, could also increases the thi==the kids--the things that the kids do. So that's why I'm saying, tomorrow, in the Rube Goldberg challenge, when you give them these materials and you tell them they have to design things, and this is what it has to do, this is a lot like what we did in stage #1 where they had unlimited resources. But they don't, but the question is how do you get them to explore how those resources can work better together so that they get the outcome they want?
[00:07:07.23]
E: did you ever built a Kinex roller coaster with five groups doing the different parts?
K: I've built Kinex roller coasters
E: Well you give them, you know, the Kinex rollercoasters, each page has exactly what has to be built
K: huh
E: I've had my students' take and make each page that's what they're responsible for and then they have to take that piece and they have to connect it to the next piece to the next piece and guess what?
F: they don't line up?
E: They do not line up. They do not line up. Because they in invariably have problems with attaching the materials, they out a cross number in wrong or they use a wrong piece, and so the dimensions are off just a fraction of an inch. And so the only way that you can actually build them is to build it from start to finish
K: hmm
E: and I thought that that was just a bunch of goofy kids. I did it five years in a row.
K: and it never worked out
E: and I did two different designs of rollercoasters, so I did two different roller coasters going at the same time, so and the kids were so confident. Oh this is easy, I've made Kinex my whole life, put it together and nothing works. [6 second pause]
[00:08:44.19] K: so thinking back to the other question about how do you get them to explore the materials to do what they want them to do, I feel like the objective for today was pretty wide open, even though it was just like build the tallest. So tomorrow it's going to be a little more restrained in that it's going to be, from this height to this height, they're going to have to move this ping-pong ball from this height to this height. I don't know that, shy of just saying it's not going to work, it can't happen, I don't know how important it is to me that they use like lots and lots of materials? Or fewer. Cause I know when I did this one thing I would be proud of is a simple design that functions well. That would be like,
J: the roller coaster thing, is that right? The elevator thing
K: yeah that one was really

J:--
K: but I would, yeah. So something that's in, a clean design has a benefit as well
E: right
K: But maybe then it's good to talk about the the very clean tripod, with very simple bracing, right? That seems, like good design even if it's not the tallest. So I don't know, I don't know how we can do it tomorrow such that they have adequate exploration to get what they want done. Maybe, in their goal statement, they should like, reemphasize what it is that they wanted to do. They had to do our goal, but maybe it's with their objectives too?
E: So where, where I'm at and I know we're I .. Is that if you're an engineer and you're given an I beam and you don't know something about the way that I beam work in space and time, okay, does it flex horizontally? What does it do under compression? Ok. That sort of stuff, then you aren't going to be able to build anything. Ok. So one of the things they never really did and that's not part of that but it is a question, at some point in time, do we want kids to have that experience that they have to know something about the materials that they are using in order to be an effective engineer?
J: Well I think they're going to get that when we do the the thermometer stuff, although [?] I don't know how much background they've had but all that material
E: right but that's very different than what we've been doing.
J; yeah
E: Structurally, in terms of like tomorrow if they're using they're using string they're using tape, they're using the sticks that we used, and skewers they have all of these different things that they have, ok, how was using one of those long things better or worse than using a popsicle stick?
K: You mean physically? What are the differences among them E: and why would you choose one or the other in your design?
J: I think we need to explicitly ask them that or
K: so this is what I was trying to ask before was I'm not sure how much these projects are about learning those engineering components and how much of them are about doing engineering design. Like, I'm not sure how important it is that they learn strain, and tension versus how much-- how important it is to attempt making a tower.
[00:12:32.09]
J: Riiiight, well part of the process though is experimentation with the, uh, the pieces of it I guess
F: you can do it with Vocab/K: yeah and we do have kids
F: I mean how long did that take? Five minutes to do two words?
K; yeah
J: cause maybe we just need to introduce the new things too, like tension, or whatever, then they'll be thinking about it instead of something
F: you should have a vocab section in their notebook
K: well definitely and I think that's appropriate but I'm saying, do you want to do like, experiments on like uh, at what radius does this become unstable? Or what distance?

[00:13:07.18] E: Well here's here's I guess where I am the only thing that I would do differently is I would have them do destructive testing. Ok? Because that gives you an idea of the limit of the, what you can do with things. So like when they were building with the spaghetti they they if you asked them what happens to a piece of spaghetti, why they built, you know why the kids built a bracing they built the bracing because they had some prior knowledge to that. They didn't build the bracing because they knew that when they put a load on a piece of spaghetti that it starts to bend, ok? [00:13:55.26] So if I used one of those long skewers, and I have it hanging off the side like this, and I put a free mass off the end of it, it's gonna bend like that cause that's the way the materials in that work. But if I take and I use a popsicle stick and I put it lengthwise, and I do it the popsicle stick does the same thing but if I rotate it 90-degrees, now I have something that's torsion-ally stable, ok? That can't be done with the skewers, you see? They have a they have a definite behavior once they are under load but a popsicle stick has two different behaviors under load. One will break with a fairly I mean a popsicle stick break with a little load, when it's flat, and it will take almost an enormous load if you put it vertically, ok? So that's the only thing that I'm saying is is that we did that they didn't do today intuitively and the question is, is tomorrow are they ready to do that with guidance or do we just keep going where we're at right now?

[00:15:16.20]

And and wait till they're ready, cause they definitely weren't ready today. That would have really convoluted the whole mess. I'm not saying we should have done that I'm saying its at some point in time cause you are the engineer, ok?, is it important that we makes sure that they have some experience with behavior of the materials before they do the design? [change in tone]

J: Yeah i think that's usual [?]

K: actually, some students identified at my table that's the purpose for having the two separate activities, that one was just to learn how things broke and one

E: but see that, but nobody at this table

J: yeah/K:yeah

E: with me

K: So/J: I think that would be a way to pull some math too since they're like putting different weights on the popsicle sticks same[?] seeing if it breaks so

E: or just measuring the deflection you know from horizontal how much it has to go before it breaks, how fa-- how much it bent

J: Right

K: So do you want to do it super intentionally? like

E: Well that's see that's the question, is it going to help in the design process to know little bit about this? or is not going to improve the outcome?

[00:16:40.28]

J: what comes the Rube thing? like what's on the schedule do you know [?-- rightnow?]

K: uh, the volume of um of a paper

E: and then on Wednesday

K: was um, getting into the big projects i think? um,

J: I think it'd be more useful cause, cause with the Rube Goldberg thing I don't I dunno,
K: Wednesday, have does Engineering create--well there was going to be a homework there and then do something with the homework
[Looking at the board/TV]
[00:17:34.05]
K: Wednesday was, students were going to do projects that related to their lives. the thermometer and the image flipper, we were going to just work on that. and then we said here, could be extended to the thermister circuit, arduino, LED thing.
E: alright, let's just go over through here [?] cause I think that we're not gonna be ... [pause] [reading the TV--insert image?]
[00:18:20.04]
E: [sigh-rubbing face in hands]
K: so Wednesday was going to be like an all-day project and then Thursday was going to get into the mega project? I dunno
J: I think it would be good to do some sort of materials testing I mean, tomorrow? Just, even if it doesn't really help[?] too much with the ... Rube Goldberg machine? Just so that they get the idea of like,
K: It's a step
J: it's a step, yeah
E: so here's where, here's where we're at. K? I'm looking at a Wednesday with the thermometers and all that other stuff and then the dog house and I'm like [pause] that's a big jump from ...
J: from making things out of straws and paper?
E: mm-hmm
J: I know [?]
K: Well that's why I thought Wednesday would be like an all-day project, be like let's get into tackling a project and it wouldn't be just straws and paper it would be the idea of plahying with a novel system and like the image flipper thing you would have to spend the time learning about the lenses and what they do at different distances and like
E: We don't have any of that equipment easily accessible right now.
K: Optics bench stuff? it's not in here? I saw optics kits.
[00:19:56.20]
E: But we're not.... what I'm saying is working on an ops-- optics bench is different than constructing something that they can walk away with. We don't have those kinds of materials
K: I wouldn't make them walk away with it
E: I I mean--so those are two different sort of activities. Know what I'm saying? One is learning about flipping something over and the other is actually constructing the device. See what I'm saying? If you're making a thermometer that thermometer is gonna walk out of here. Should have the potential to walk out of here.
K: And making the thermometer thing I thought would not walk out of here, it would be looking at different caliber, different um, different diameters of tubing, different liquids, different ways to make it move, different I mean it would just be--

J: So do we actually construct these things? Would they just sort of make up a design for making them based on what we've done, I dont' know, or what we've learned about the materials?
E: Well see that's where we're at here, is that
K: we'd make them
E: Is that on Wednesday, every thing that we have done when those materials were done, they were done, tomorrow when the Rube Goldberg [tone?] thing is done it's done. So Wednesday when I saw this I was thinking same thing but they would have something that they could technically take with them. See what I'm saying? That they're constructing something that they're not doing--not like measuring the inverse square law where there are some light sensors and that sort of stuff, that they were actually constructing something. So if you're making a thermometer whether it's a thermister or whatever, it's something that physically been constructed that they can use in the future.
[00:22:00.03]
E: See what I, you see what I mean?
K: Yeah but I don't think that means that it has to go with them to their dorm room and then their casa. We're not giving them the Arduinos either
E: no
K: we're not giving them LED strings. Like they can make it and use it here.
J: And do they have or do we have the materials to even make a thermometer? I guess or--
E: Well, what I'm saying is, is what we're transitioning from is and I'm not here is that we're going from rudimentr--we're going from very easy to assemble materials and then what we're doing is we're creating more and more robust measuring devices and as you get into the Arduino part of things there are things that are here that they're able to use to construct that will stay on their lab tables and stuff, but they're constructing a system that could permanently be used and stable as uh functioning device. so when they're done with the Arduinos and the LED strings, if , if that was the decision of the university that or whatever, that would be a permanant thing. Like putting a window in a wall, that's what I'm saying is that it's different and I'm and I'm not saying this well but
K: I don't see how but, I mean, if they wanted to they could walk away with their spaghetti things, if they wanted to and we let them they could walk away with image flippers, making them out of mirrors and lenses. But we're not going to give them mirrors and lenses. But they could, they're going to create a functional product--a thing housed in cardboard, housed in whatever, that works, that is a thing.
[00:23:50.22]
J: But how do the, ok, so the lens that they--
E: Ok but that's not what you jsut said you said we have optics benches
K: Yeah but to explore the things like focal lengths, sqitching images, real images, virtual images. You could have them explore those things on an optics bench. You could have them construct things with the lenses removed from an optics bench.
E: Understood
K: K

E: But how so this goes back to the the testing stuff, alright? in order for them to do that they have to understand how the stuff works. K?
For the first two days and that's where where we're stuck here is we're we're going to spend a whole bunch of time and I I ... [leans back] [long pause--time it] Just talk amongst yourselves, go ahead, I'm just thinking, my brain it's churning
[00:25:01.20]
K: I just think it's a different level of expertise required to work with concave versus convex or lenses or mirrors. That's a different level of expertise than say I'm asking you to tape spaghetti together, right? And I don't think that, I can see why it might be useful to talk about it and kind of scaffold that idea in to whatever we do in the next several days so it becomes more natural to ex--to investigate materials when you receive materials. But because it was like, spaghetti [emphasis], and earlier than that it was
[00:25:35.07] F: newspaper
K:newspaper [emphasis], yeah I felt like there was a lot of structural integrity stuff we could have done with newspaper like why are you rolling this so tight? you know? What was the best structure of that newspaper is when you roll it really really tight you get these really strong tubes, some kids got that some kids didn't, and I would ask them like, why are you rolling it tightly? and they'd say "cause it's--becuase it's stronger" and some and I was like, like a pixie stick, you know like? it's and we didn't [?] talk about how you could make the brick holder the strongest. Some kids did it they made cylinders and they made them wide and low, that's a really strong shape, so, I feel like again, this is what I was trying to say right there, I'm not sure how important it is to learn about the structural integrity of the designs. [00:26:22.24] If we're really trying to teach them like we have I-beams down there, we have plastic I-beams in the physics department that we could mess around with we could talk about like real structural integrity of things as if we were training them to be engineers but I didn't think that was the point. I thought we were just having a camp about engineering design and like the ways that engineering design can be accomplished and giving them multiple examples of that and then yeah, I agree, it would be really cool if they also learned about programming, or also learned about Arduinos, or also learned about LEDs and circuits and maybe they learned about some heaters and some resistors and stuff but like I thought the whole point was that it's an engineering camp--engineering for innovation not necessarily engineering to learn about the structural integrity of spaghetti or popsicle sticks. [00:27:10.08] So that's where I'm kind of like, I don't--If we're going to make that a focus then let's make that a focus. All the other leading questions and everything I've been throwing out, everything I've been talking about now for months has not had to do with that, it's had to do with designing for innovation and for helping science. That's what we've been doing--
E: That's why on Wednesday I'm having uh, I
[00:27:36.00] K: it's not--I'm sorry but I wasn't quite done yet--it's not a materials engineering course. I need you to tell me if you need this to be a materials engineering course.

E: No, what I'm saying is, On Wednesday we're spending a whole lot of time learning about lenses that really doesn't have a whole lot of application that anything except for making this one box.
K: or telescopes or whatever glasses or photos or their iPhones/J:[?]part of this/K: or anything telescopes
E: But but you understand what I'm saying is is is that we're spending a whole lot of time for that one thing to learn some basic background stuff but when it comes to the materials part of this stuff, we're just saying, you really don't need to know that to build these things K, but you see what I'm saying is is we're making a real change on Wednesday in terms of how we're approaching the the way they're going to build these things is because they're going to have to learn about it, we'll do stuff with the optics benches, they'll learn about um, all of these other things, yet in the first two days, we have just said, be free and explore and I, I think that what's missing is is that-- [00:28:52.01] I, I have no, everything is good, I just see that all of a sudden that it becomes really important to know about lenses and the size of the tubes and all of those other things but for for the spaghetti, had they known and thought about this and that's why I'm looking at the Rube Goldberg tomorrow thing is how do you transition from a very open-ended thing to something that is more structured on Wednesday where they're going to have to know things about focal length, real images, about um, the changes in volume and measuring with temperature? uh, you know those sort of things that have very very vert precise mathematical ratios that they're going to have to become aware of, either randolmy or through some investigation versus tomorrow where we're going to say I want you to find, design the lifter and I want you to design ok, it's counterpart and you're goign to swatch plans and put them together, yet, they [pause] [00:30:00.08] They can, they they don't have to think about any of the reasons why they're put using the pieces parts that they're chosing to make that work. You see what I'm saying? When you're 14 years old and if you've done this with the other groups, those people had a lot of I mean, it's a question of how much knowledge that they have about the materials. I would have built very very different structures than the kids did with the spaghetti. Because I know something about the mechanics of the way spaghetti works. K? Same thing with the newspaper. So my prior konwledge changes the way that I would have approached that and so I'm, what I'm saying is is as we transition tomorrow do we and then we go into Wednesday and then we go into the Arduinos and those other things, they have to scale up their background knowledge even to be able to do these things. Does that make sense?
[00:31:11.09]
J: Yeah, I think the bringing in the lens stuff is probably--it seems to me like that would be a good time for them to have to start investigating materials because before that like they have an idea of the spaghetti, right? or you've seen them just like balance along the top [?], so they kind of they're familiar with the materials. But then when we get to Wednesday when they're not familiar with the materials they can't just jump into design. They have to do some investigation so that might be a good time to introduce to them the idea of like you have to know how these materials work before you can actually do anything with them. Katey?
[00:31:45.04]

K: Yeah, I mean, I think we can do that tomorrow too. The twist in that project tomorrow some of the, like, one of the twists is that they don't get the same materials, so investigating one material and then designing your piece to include that material and then giving it to someone else that investigated a different material, I mean I think that's, that's all okay, we just have to understand that that's what's going on.
E: And you have to assume that the person that gave you the design knew what the heck they were doing and understood how to make this so that when you go to use their plan that it's going, going to work.
K: Yeah
J: Yeah
[00:32:22.14]
E: That-- that's that's the level I mean, that's the level of expertise that we didn't have today. You know, we put stuff together and learned some things through each iteration, but they really didn't, I mean, when we talked about writing stuff down and those sort of things we we, I, we just seeing what they would write down is important, and most of what they wrote down they could never repeat. Nobody could repeat from what they wrote down. If you're going to hand something off to somebody else tomorrow, you better be pretty darn sure that the plan that you give them is going to work.
K: Definitely
E: Ok? That's not going to happen by trial and error. By them just taping stuff together and hoping everything works like we did today. They have to have a different a way of approaching the problem and that includes understanding how to use the string and tape and uh all the other things and, and what is the benefit and, and of using one versus another in their, their design. you see what I'm saying? And so, so if we just and so
[00:33:41.02] If I sound argumentative that's okay because I'm not trying to be argumentative but but I'm trying to say, how can we transition from very open where you you don't concern yourself to all of a sudden where you were very focused and we have to know everything about the way a lens and a mirror works in order to construct our final projects, you see what I'm saying? It's a big difference in the way that we approach things.
K: Well, it's also like saying we are going to value the way a lens and a mirror works
E: or
K: Because we don't have to know the way it works to mess around with it until it works.
E: That's right, and that's, that's where I'm at is is that we're saying, I feel like we're saying you don't have to concern yourself about the materials that we're giving you, just come up with something that will work and whether you know why it works or not really doesn't matter just as long as you can make something that works. It's the valuing thing.
K: So the point is that we want it to scaffold the importance of an understanding of materials?
[00:34:50.13]

E: Right so that when they get to the more complicated things that rather than just trying to fly by the seat of your pants when we get to LEDs and Arduinos and whatever else that we do, that we stop and say, hey, I don't have enough information here, I'm not going to just push on, I need to have some additional instruction or I have to get I have to find something out. [pause] Cause as we move on, the amount of stuff that they need to be able to do that's why I wrote the checklist.
The checklist on Wednesday the check--, if if we did things the way we did them today the checklist for tomorrow would be three things. just like we did today. Brainstorm, build, send plan over. Know what I'm saying?
K: mm-hmm [00:35:57.20]
E: With the stuff on Wednesday, it's going to be number one, you know, investigate what a lens does. Ok, so that's where real and virtual images, focal length, uh, difference between convex and concave, um, difference between plane mirrors and curved mirrors, all of those things can come in to that and there's a whole bunch of checklists that they if they know something about the way those things work, then the construction of their, their device becomes much easier. see what I'm saying? We could just give them some lenses and mirrors and tell them to make a flip over thing and they probably given enough time can do it. But exploring the way the lenses and mirrors work increases the likelihood of success for the project.
J: Well could we do like a need-to-know thing before we start?

CLIP 2
R: [To Evan] Is that actually a day, when they end up having those kids working with the lenses? The, that'd be a realy intersting exercise
K: Yeah
R: It's, they enjoy, my summer program in june I had the students, uh, working with prisms, and diffraction gratings, and
E: Right
R: Simple spetroscopes, it was so enjoyable for them, very enjoyable
E: But we're not going that we're looking at learning the waht, how lens and mirror work so that we can take those to create a product.
R: mmhmm
K: So all of this engineering with a um, with a goal you know that's not gonna be just an investigation, it's going to be, "we want you to make a product that does this. so you'll probably have to investigate what these objects and items that we've provided you--"
R: Right
K: "can do."
R: We could make a simple telescope
K: yeah
R: we had some spare lenses
E: Which we don't
R: that would be really interesting
E: Which we don't
K: Sure we do. Didn't we talk about it?

E: We have lenses, some lenses that go on the optics benches, but those can't be taken out and I mean they jsut redid all their their they have a whole new optics room.
K: We're not giving away any lenses
E: but what I'm saying is is when is if we're taking and taping these things into cardboard and stuff like that that's something that we can't do unless they have put the old lenses somewhere that we had. The, see,
K: So I'm thinking of that file drawer-looking thing that has lenses in it.
E: And I don't know that that exists anymore
K: Oh. ok
E: because Centennial is completely different than it was
K: okay.
E: that room that we were in on the end is has a whole crapload of tables the room that was the electronics room was completely different.
K: okay[00:02:10.06]
K: So we'll need to investigate that
E: That's correct
K: So
E: so like right now in the back of this are optics benches and all the stuff that you need to do lenses and mirrors and all of that other stuff.
K: They could do a simple telescope set-up on an optics bench. They would have to figure out where to place them, how far away they could see, how to position them to see something particular we could tape a stamp to the wall and have them, have them figure it out for that, i mean, you know, that would be a slight variant on the idea of creating an optical instrument. I was thinking they could do this image flipping thing but it doesn't matter to me.
E: to me, we built telescopes many many years ago. And um, and then we brought, I brought in all of the lenses and and we went through the same sort of thing that you were talking about cause we were using talking we did the lenses and stuff to talk about the way that you could gather information from a distance. Ok? And the telescope was a way to get them to do that and then we built pinhole cameras as a as a collector. And then we actually took the telescopes and the pinhole cameras and put them together and made images through the telescope with the pinhole cameras. which was really quite an ordeal. now that whole process took four and a half days.
K: Yeah, i'm not suggesting we do all that.
E: no no no, but what i'm saying is, is in or--it's a qustion of the degree of understanding that you want them to walk out with. And so, I--I would-- what I would like do is I would like to focus--I would like us to say what is going to happen tomorrow with the Rube Goldberg project, if there's going to be any structural component that we're going to add to it or if we're going to stay the way that it were originally was um, addressed. And then on Wednesday then, how we're going to transition from what we've been doing to this.I don't see a smooth transition from Tuesdsay to Wednesday right now. That's where I'm having a problem.
[00:04:48.27]

K: Well it seems like we should definitiely do some structural stuff in the Rube Goldberg project. The other part of the project was the like the other half of the day was the volume thing. And the structures there would be paper, again, and like Kix and whatever we get. So, I don't know what we'd investigate there except like,
J: Well we could do if we have different things to fill it up with we could investigate those like stacking, or--
K: Why are they different volumes for the same--
J: Right, why...which ones when measured gives us more accurate volumes and why does it give us more accurate volumes
K: So you're kind of investigating the testing mechanism?
J: Yeah, which is not I mean, it's not build it but it's...
E: Well uh that's not, I mean, it's not, uh, I mean, that's the difference between a high-calibur, I mean, the reason that you pay big bucks for precision tools is because of the the digits. ok?
J: ok
E: so using sand versus cocoa puffs is going to give you more digits, but it's way harder to work with sand than it, in those containers, than it is cocoa puffs. [00:06:11.12]
K: Right
F: also depends...on how you do that [?]
K: So we can talk about I mean we can definitely do like investigation of structures when they start to plan their half of their pie--of their Rube Goldberg. And we can ask them, I think that's a like a fine thing to do.
E: see the, it, and this is where I and I need a hug
K: [laugh]
J: [laugh]
E: cause I I feel like I'm yelling at you and I'm not.[00:06:38.28]
K: I don't feel like you're yelling at me, I just still don't quite get it like you, when they have to make something with lenses, they're going to have to know about lenses. When they have to make something with popsicle sticks, they don't need to know much about popsicle sticks. So I just I, I think that it's an okay exercise to get them used to thinking about how you have to know about it before you build with it, and I think that's a valid--that would be totally great going into tomorrrow cause today we did this design crap, we made the little cycle diagram, we practiced taking the notes, we kind of did that first like toe in the water of engineering design and we talked about how "you could be an engineer" and stuff and that's all happy go lucky stuff. I think it's find to ramp up the science-ness and the, the rigor of it. you know, get in to "how can we destroy this thing and measure how it was destroyed" and that would be really great with popsicle sticks, with skewers
E: but i'm not even, I'm not even, I'm not even going to that point. K. what I'm trying to do is look through all the course of the day and say, alright, we're going from today which was very loose and open and then tomorrow we start out at in the first way that I saw it as being loose and open, and then in the afternoon we were going to be using the rice and the puffs stuff and then now and then there were there were, we talked about the difference between the volumes of using rice versus the puffed wheat because they don't stack on one another, and so what we're doing then

is, is we're asking kids to now become much more precise which I'm I'm good with, and i can see how that can transition into the, the to Wednesay talkign about Now, you, in order to be able to do things you need to do more and more, you need to know more and more you need to use different tools, you need to become, you need to make your measurments differenty, k? and so if they build this and we have to say you have to measure your volume with sand and and rice and cocoa puffs or whatever, puffed rice and those threemeasurements all have to be put into your data table, and then we start to ask, with the, the ultimate thing is, which one of these things is right? ok? what is the volume of your object?
K: yeah
E: ok [00:09:09.20] becuase if they graph the cocoa puffs graph, it's going to be a big crazy scatterplot, but if they do um,
J: sand?
E: sand it's going to be very little error.
J: mm-hmm
E: ok? and then um, the next thing then that comes into alright, so when you're working with the lenses, uh and we can say, Yesterday we saw that you can measure volume in a variety of ways and that you that by using one way you can get a different product outcome than another, if you were an engineer, and you had to work with lenses and mirrors, what would you do? you not, I'm jsut saying this is my head, what would you? We have to know about the lenses and mirrors. ok? I'm not saying that we need to do a full on structural analysis of the way popsicle sticks bend, break, and all of those other things. But what I think was m---what ha--will improve the liklehood of success is kids at the different areas is number one is that they can't just rely on their past experience. Which is what they did with the spaghetti towers. How do we get them to take these things and say, Alright,
K: What can it do first?
E: What can it do first?
K: What can't it do?
E: How can I use this in a way that was unexected.
J: Yeah
E: So like, with that string, nobody used the string. Nobody used the tape, okay, what they did was they used, I mean, they left things, they left opportunities untrod. That's all that I want, all I want is so that when they get to the next level here as we move on that when they run to get to a frustration level with the Arduinos or whatever we were using, that they don't simply say, Well. It can't be done. [pause] You know what I mean?
[Katey drawing a diagram—see images]
[00:11:28.04]
K: So that's sitting with me somehow more easily than what I thought you were saying which was that you want more of mechanical engineering
E: No, not at all, I want--
K: Cause I didn't know that
E: No, no no. What I, I think,

K: So I think that if we're trying to get at... and how can I overcome problems, basically, how do I use all of this to overcome problems, intelligently, without just random guess and check.