SARAH HANSEN: So how did you become interested in computation structures?

CHRISTOPHER TERMAN: Well, in the early '70s I was a college student trying to earn my way through college. And so I was the computer operator on the third shift for the campus computer. That was in the era in which you could only afford one.

And since watching the blinking lights was boring, I pulled out the schematics for the computer I was running for the university. And I started trying to figure out how the computer worked. Ever since then, it's been sort of a lifelong interest in figuring out, how do they actually put together these components to make a machine that can do computation?

SARAH HANSEN: And that interest is coupled with your interest in teaching and learning, and especially online education. Could you talk a little bit about where that interest comes from?

CHRISTOPHER TERMAN: Well, I was always fascinated and very motivated by the great teachers I could listen to. And so everybody picks a model when they're a teenager or a young adult. They say, I want to be like so-and-so.

Well, the so-and-sos I liked to pick were the excellent teachers I had. So I said, I'm going to try to be the best teacher I can.

There's something very satisfying about teaching students and having them nod and suddenly get it. So it's been sort of a very fulfilling experience to teach.

And so that's sort of a virtuous cycle, right? You get good vibes from teaching. And then you do it better next year. And you get better vibes. And so for 40 years, that's been a great-- it's been great.

SARAH HANSEN: What kind of background experiences do the students bring related to computation structures?

CHRISTOPHER TERMAN: It's all over the map. It's all over the map.

So some of them will come having programmed computers for a long time, and maybe even know a little bit about how the computers are structured on the insides.

Other people have not done beans. They're just-- I wanted to take a course. I've used

computers, sort of browsers, laptops, email, sort of thing. But they have no idea about the OS or the actual hardware inside. And so they come with interest, but no background at all.

SARAH HANSEN: So how do you structure a course to meet the needs of people with diverse backgrounds like that?

CHRISTOPHER TERMAN: Right. So to handle really diverse backgrounds, you have to have a huge range of materials. So you need something that somebody who just-- I need to start at the beginning. You need a beginning for them to start at.

And for somebody who's sort of past the first half of your material, you need a second half which will engage their interests.

So I create a huge-- I think of it as a buffet. There's lots of dishes. And you can start at the beginning of the buffet and sort of pick it up from scratch. Or you can say, I'll skip the first couple courses, and I'm ready to dive in sort of in the middle of the conversation somewhere.

So I think the real key is having a huge selection of materials to draw from. And that's, I think, one of the hallmarks of 6.004 has been that we have every possible way of learning the material. So not only for different backgrounds, but for different learning styles.

So some students want to talk or listen. Some students want to read. Some students just want to work on P-sets and do just-in-time learning, where they sort of say, here's what I need to know. Now I'll go look at the material, just find the worked example, and if I don't understand the worked example, I'll go actually read the text.

So they actually only get to the beginning of, if you will, the introductory or the explanatory material only, and as a last resort if they somehow didn't pick it up from before.

SARAH HANSEN: That's interesting.

CHRISTOPHER TERMAN: So many different learning styles, many different backgrounds.

SARAH HANSEN: How has the MITx Residential platform enabled you to provide this buffet?

CHRISTOPHER TERMAN: Well, one, it's a one-stop shop for all the different sorts of materials. And the other is there's sort of an emerging best practice about how to explain material to people for the first time.

So you want to do short bites; sound bites, video bites. You know, those short segments of learning where you introduce a single skill or a single concept.

And then you take a moment to actually give them some check yourself questions. So the idea is in theory you just listened to this or watched it. I'm going to ask you some simple questions, not puzzlers. They're just if you understood what I just told you on the video, then you can answer them.

And so that gives those students a chance to start the process of retrieval learning, where you keep coming back again and again. And I'll ask you a similar sort of question two segments later. And pretty soon, you're pulling it out of your short-term, and then medium-term, and long-term memories.

So the MITx platform works really well at letting you construct those sort of learning sequences. And I think the students appreciate it. Everything is more and more bite-sized.

We both know, as you can imagine, pushing play on a 50-minute video and along about minute-- well, I'm going to say 37, but along about minute six, you're going to be, all right, maybe I should check my email while I'm listening to this.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: It's keeping things short and sweet. So you have a huge-- because now you have a bunch of short bites. Now, the MITx platform lets you organize those with questions that let you sort of continue to test your learning.

So it's actually worked out to be a very nice way of making a fairly organized tour through the material that the students can start, and stop, and come back to.

Plus it's asynchronous. In other words, they get to choose their time and place. And us teachers always have a fantasy, well, they didn't come to lecture, so I'm sure at 3:00 in the morning when they're wide awake, they're actually watching it.

SARAH HANSEN: Of course.

CHRISTOPHER TERMAN: If you actually look at the statistics for the viewing, there's a lot of viewing that happens in quiz weeks.

So a lot of people may be using it as sort of a, OK, I want the intense, immersive introduction

to the material.

SARAH HANSEN: Right. This must be just such an exciting time for you as someone who's really interested in the scholarship of teaching and learning, and then the emergence of these digital tools to enable that learning through best practices. I can feel your enthusiasm for kind of the era that we're in.

CHRISTOPHER TERMAN: Yeah. Well, so much of how us people-- or those of us who teach at the university level, we get handed a piece of chalk and be told to teach, unlike the teachers for your kids in elementary school who've actually gone through a program that teaches them how to teach. We're just said, here teach.

And so it's all anecdotal. It's all trying to remember how people taught you.

Finally, we have the online courses providing a real educational laboratory. We're able to try out different techniques. We're able to make fairly accurate assessments of how well did that just work, whether it was an exercise, or a video segment, or a design problem. And so we can actually do A/B tests in the same cadre.

So it's pretty neat having a lab. I mean, as a scientist and engineer, you can say, look, I know about the hypothesis. Test it through a bunch of experiments. We can really do the experiments with the MITx platform. And so that's been great.

SARAH HANSEN: Yeah, it's really exciting.

CHRISTOPHER TERMAN: It is.

SARAH HANSEN: Let's talk about learning in the classroom and teaching large lecture classes. What strategies do you have for keeping students engaged?

CHRISTOPHER TERMAN: Well, that's interesting. Because we have so many different materials, really the only students who come to lecture are the ones for whom lecture is how they learn. And I was such a student.

SARAH HANSEN: I see.

CHRISTOPHER TERMAN: So the people who are there are not a draft army. They're all volunteers.

SARAH HANSEN: Self-selected.

CHRISTOPHER TERMAN: So they're prepared to be somewhat engaged by a vocal presentation.

SARAH HANSEN: I see.

CHRISTOPHER TERMAN: So I have a well-developed set of materials that I present in class that have sort of been debugged for having not too much or too little. A progression that most people can follow.

And then happily, when you teach for a while, you start to get more relaxed. And so it's a very relaxed sort of experience. I tell jokes. I tell stories from my career.

And it's interesting to me how when the students are making comments at the end of the semester on the evaluations, many of them say, I really liked the stories.

SARAH HANSEN: Interesting.

CHRISTOPHER TERMAN: So after boring you with technical details, it's fun to say, and then when I tried to use that, this following thing happened. And all of a sudden, they're sort of perking up, saying, oh.

SARAH HANSEN: And I think it helps them remember the related content, too.

CHRISTOPHER TERMAN: It does. It does. When you think about what you remember from lectures, it's almost never a technical nugget. It's a joke they told, or an accident that happened, or a mistake that was made.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And so it's-- there's this concept called fluency, which is basically how smoothly things are going, and everybody's nodding. So your mind is starting to drift, because it's all-- so it's actually good to try to put a little disfluency into your lecture, to actually have a-- you stop, and you tell a joke.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: Or you make a mistake, or you drop the chalk, and say, darn, and you look at the floor.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And here's what I like to do is you walk out from behind the lecture table or lectern, and you approach the audience. And you can see them sort of going, wait, he's escaped.

So just anything that sort of switches up the sort of I'm just going along with the flow here. So making little flows that have things that change make a lot of difference in keeping people sort of engaged.

SARAH HANSEN: That's a great tip.

Let's talk for a second about the teaching team. I understand there are a fair number of people involved in developing and teaching this course. Could you talk about that?

CHRISTOPHER TERMAN: Well, we have a little cadre of people who are instructors. I've been sort of part of that cadre every semester for a very long time.

But we have other people who come in from the outside. In recent years, the department has added lecturer resources. So there's another lecturer associated with it. And then faculty come in. And they provide a little depth to the gene pool.

SARAH HANSEN: Sure.

CHRISTOPHER TERMAN: But then we have graduate TAs who teach recitations. And we have student undergraduate TAs, and then lab assistants.

So sort of we have this whole hierarchy. They've all taken the course. Almost, they've all loved it. So I mean, it's sort of the material that people say, oh, this is really pretty neat. I can't wait to tell the next person about how this works.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And so as they sit there and work with the students, sort of like me, there's an enthusiasm that sort of bubbles out.

SARAH HANSEN: It's contagious.

CHRISTOPHER TERMAN: Yeah. And the students actually-- I sort of listed things sort of-- well, I was going to say top down. I'm not sure lecturers are at the top or instructors are at the top.

But the students actually prefer the other thing, which is actually asking an LA is not very intimidating. The students, maybe they just took it last semester. And so they have it fresh in their minds what it is they needed to do in order to get whatever it is they're trying to get.

And then you sort of work the chain up, work up the hierarchy to get an answer of people below. And that way you're only asking questions of the more intimidating people when you're pretty sure that no one else has the answer.

So it's really-- by the time the questions sort of get to me, mostly no one is worried that they're a dumb question. Now, I don't really believe in dumb questions. I think all questions are sort of interesting.

But I think the students are, look, I asked 10 people. None of us knew, so now we can ask you. And I'm pretty confident that it wasn't an obvious thing that if I only read the assignment I would have known.

So that sort of range of sort of experience level and age, at the high end of the experience level, you can get an answer to any question. At the beginning end of the experience level, you're talking to somebody who--

SARAH HANSEN: Just had that experience

CHRISTOPHER TERMAN: Just months ago did what you're doing. And so we can be-- I can ask you, and we won't be embarrassed.

SARAH HANSEN: Right, right. What's the role of the online fora in the course for helping students feel comfortable asking questions? And how do you monitor it? How do you run it productively? This is something that educators sometimes struggle with.

CHRISTOPHER TERMAN: Well, I mean, to me, it's a wonderful asset. For the first time I'm able to make a thoughtful answer to a question and have 180 people look at the answer instead of one. And then the next person who has the same question, you say, well, I just spent 10 minutes. And with a large class, you can't spend 10 minutes for each of 300 people.

So it's a great place to ask questions. I try to always give a thoughtful and respectful answer to each question. So even if the question is sort of like, well, if you had done the reading, you would known, I say, well, if you look back at the material, you'll see it explains the following. Try to make it not-- a little hint that maybe a little bit more preparation.

But many of the questions are, look, I read the material. I'm still not getting it. I need an example.

And so the students, I try to make students feel very comfortable asking. It's never-- there's nothing. No cost. They can ask anonymously, so that removes some of the barrier.

SARAH HANSEN: OK.

CHRISTOPHER TERMAN: And then I think-- let's see. In the fall of 2017, we had about 2,500 contributions to the forum.

SARAH HANSEN: Wow. OK.

CHRISTOPHER TERMAN: The average response time is about 20 minutes. And so you say, wait, but students are asking questions at 3:00 AM. How does that work? And it turns out that we have TAs. We particularly have some really good--

SARAH HANSEN: Nocturnal TAs.

CHRISTOPHER TERMAN: Yes, exactly. At 3:00 AM they're just hitting their stride. A lot of us who are involved in the course sort of have-- we put the notification of postings on real time. And so we get an email right away. And so often we can just type in an answer. And it's--

SARAH HANSEN: OK.

CHRISTOPHER TERMAN: And I'm really-- I think the fast response time really reduces the frustration level of the students.

SARAH HANSEN: Ah.

CHRISTOPHER TERMAN: There's nothing like being stuck on something.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And say, I wish I could ask somebody. Well, for the first time, it's 3:12 in the morning. And you can say, wait, I can ask, and I can get an answer. And the students really, really appreciate that.

So the forum has really, I think, changed students' level of frustration when they get stuck.

Being stuck is just a 10-minute process, not a two-day process.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: My god, the next office hours are after the weekend. What do I do?

And of course, a lot of students are doing work outside of sort of 9:00 to 5:00 hours. So it's a way for the staff to be a 24/7 staff instead of just a 9:00 to 5:00, five days a week staff.

The staff like-- and then the students work like that, too. Most of the people who are helping on the forum are keeping the same schedule as the users of the forum. So it's a good match.

SARAH HANSEN: OK. Let's talk for a minute about the lab experiences in the course. So students get hands-on experience doing digital design.

CHRISTOPHER TERMAN: Yes.

SARAH HANSEN: Could you talk about a few of those experiences? And also, does that take place here where we are right now?

CHRISTOPHER TERMAN: Well, you can do it anywhere. It's browser-based. So there's no software to download. It's just on the web. You go.

SARAH HANSEN: I see.

CHRISTOPHER TERMAN: And so one of the things I enjoy doing is to build browser-based computer-aided design tools. It turns out that they actually work really well. The modern browser environments are quite capable as a programming environment. You have to learn a few tricks, but once you do, it works well.

So they're reasonably high-performing tools. They can sit down and do. Much of the design work we do is sort of design-driven learning, where we're actually trying to get them to build something that we've described.

SARAH HANSEN: I see.

CHRISTOPHER And we may have even told them in quite some detail how it fits together, but there's

TERMAN: something about the old muscle memory bit about if you actually build it yourself, drag the components on and wire them up, you'll remember it much better.

Or you'll ask yourself, wait, does this go here or here? And then you say-- then you look back, and you're starting to say, I'm looking at this diagram, the instructions, for the first time with enough care to appreciate that, oh, I have to put it this way in order for it to work.

And so we're sort of-- hand and eye are engaged. It's not just a listening experience. We are able to-- if you assemble something, we build tests to see if it functions correctly. And so you can tell right away whether you've screwed it up. It's not like, well, I turn it in, and a week later-- long past when I've ceased to care-- I get back a red X. And I say, OK, well, dang.

So here they have to get it right in order to complete it, but we tell them right away that it's not right. And they keep working on it. Or they post on Piazza. My circuit doesn't work. The staff can pull it up remotely from the server, and say, oh, here's where-- here's your mistake.

So the idea is that the students are actually being engineers. This may be one of the first actual build-it experiences they have. Again, these are sophomores, right?

So it's a little bit of fun to say, well, this is sort of neat. I've actually put together the circuit and debugged it. So I had to say, well, what was wrong? I got a wrong thing. What did I do wrong? And then fix it. So that's a very valuable experience.

So it's one thing. It's like the late night TV salesman. When you watch them, use it. It's so easy.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: But you get the widget home. And it doesn't work. And so that's-- they've seen it in lectures. They've seen it on the videos. They've seen it the worked examples. And it's all extremely obvious that this is straightforward until you do it yourself. And then you fill in all the pieces, that you were just being, oh, how hard could that be? Oh, now I know.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: So they work hard at trying to fix that.

And I think the whole idea of these virtual lab benches is great. As I said, the execution

environment and the graphics environment on the browser is first rate. It's very easy to build sophisticated tools that use reasonably complex calculations in the background and have a really great user interface.

And the browser is portable. So 20 years ago I gave you software to download on your computer to do this stuff. The landmine that was. Everybody's environment was a little different. Oh, you don't have the latest version of that library? Well, you can't run this. But if you update your library, you can't run that. It was really a nightmare.

So packaging things-- packaging up these lab experiences in a way that they can be used by people around the world.

So here I was. I was riding on the Hong Kong subway. And some young adult comes up to me and says, I took your MITx course.

SARAH HANSEN: Really?

CHRISTOPHER TERMAN: And I really loved doing the circuit stuff. And I didn't have to download anything.

And I'm sort of going, wow. I mean, this is--

SARAH HANSEN: It's incredible.

CHRISTOPHER TERMAN: It is. It's interesting to be stopped by people.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And they start talking about how this was more than just a listening experience. So these virtual labs actually go from being something that-- I mean, it takes courses from being a listening experience with maybe some pencil P-sets to your hands are active.

So hands-on, brain on, right? And when people's brains turn on, it's amazing what-- they remember it.

SARAH HANSEN: Right.

So what kind of challenges do students encounter when they're trying their hand at being engineers for the first time? Is there anything that tends to pop up again and again?

CHRISTOPHER TERMAN: So I think a lot of this is sort of competence. So people sometimes-- the students come to me, and say, I want to make this work. And I say, OK, let me look at your design. Let's fix it.

And I go through. And I try to keep my hands in my pockets and let them do the fixing. But I say, have you thought about this? If this works and that doesn't, what does that tell you?

So a lot of students aren't very good at taking the information they do know and using it to deduce the next thing to try or the next thing to test and to narrow down where the problem is.

So there's a real-- there's a learning-- something you have to learn how to do is to be organized about how taking something that isn't working-- or complicated things, so parts of it are working, but something isn't. And trying to work back from both ends to somewhere in the middle that doesn't work.

And so that's a skill that you have to practice for a while. And we try to help with that skill.

I have a lot of confidence that will work. Most students are pretty convinced that either the simulator is broken or is hopeless. And so they're somewhat surprised to realize that there is a systematic way to make something that works.

And once they are convinced that that's actually true, they are getting more confident that, oh, it doesn't work now, but I'll just work on it for 10 minutes, and I'm sure it will. As opposed to just saying, oh, the only thing I can do is to raise my hand and say, could you help me? Because it isn't working.

So we try to get the students out of, look, your job is to actually make it work, not to merely ask us to come over and watch us make it work.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And so students make that transition through the course.

SARAH HANSEN: So it seems--

CHRISTOPHER TERMAN: The course of the course.

SARAH HANSEN: Right. So it seems like a learning goal in the course is not only learning the architecture of digital systems, but also developing professional competencies in the sense of attitudes that engineers embrace.

CHRISTOPHER TERMAN: Right. There's a bunch of processes that you have to go through.

SARAH HANSEN: Processes.

CHRISTOPHER TERMAN: And the same thing is true of all learning. Learning how to learn is something that sophomores are still doing.

And so this is probably the first time that they've been sort of thrown into the deep end. We try to have lots of lifeguards standing by. But we're prepared to do more than just check off on our clipboard, sink or swim. I mean, we're ready to dive in, and say, OK, try this. Try that.

It's actually pretty helpful to have an experience like this after your freshman year, which has a lot of training wheels, but before your upper level classes where help is a little thin.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: One of the great things about 004 is that half the people on your hall have taken this course. And so even though we have our core staff, you can go down your hall, and as I say, every other person will say, oh, I took the course.

So there's actually an enormous body of knowledge about the material and things like that. So not many courses have that opportunity, but we take great advantage of it. So there's a lot of sort of hallway learning, peer learning that happens outside of the sort of structured learning that we do in the class.

SARAH HANSEN: That's fascinating. It kind of speaks to the importance of having common learning experiences at the undergraduate level just to facilitate that sort of, like you said, hallway learning. It's really interesting.

CHRISTOPHER TERMAN: Well, plus students often-- during the day, it's hectic.

SARAH HANSEN: Yes.

CHRISTOPHER TERMAN: They're distracted. They come to lecture. They have lots of things on their minds.

So mostly it's being in the quiet of their room that they probably intellectually really grapple with the material. So first of all, giving them things to grapple with is good, but then making sure they're supported, either through peers or through the Piazza forum. When they're outside of the sort of structured help we provide.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: It's really, I think, changed how the students consume the course. And so the lecture attendance is modest. But a lot of people do very well on learning the material on the assessments.

SARAH HANSEN: Right. I mean, I think that speaks to what you talked about earlier in that you offer a buffet of ways to learn. And so people who come to the lectures are the people who learn best through that format.

CHRISTOPHER TERMAN: Right. And some people I never see except occasionally they'll come when I have lab hours. They'll come by, because they just want to chit chat, right?

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: We have-- one of the activities you do after you do the design, we have a check-off. So you have to come and sort of explain your design. Partly that's just to make sure that maybe you actually did the design instead of your friend down the hall.

SARAH HANSEN: I see.

CHRISTOPHER TERMAN: And so at the very least we want them to understand the design that they claim they have done.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: But for people who have worked hard on it, it's an opp-- they love to come by and show it off. And so they're proud of their baby, right? I mean, particularly towards the end of the course when we have a fairly complex design project, which is actually very hard to get very high marks on. I mean, you have to be really good to get it.

And so it's an amazing number of people who tackle that. And they come in. And they say, OK, I'm stuck here. Give me some ideas what to try next.

And if you dare try to say, well, just do this. I don't want the answer. I want you to-- I'm having fun here. So don't take away the fun part. I want to puzzle it out myself. I just need some hints as to where my puzzler should be focusing.

SARAH HANSEN: The fun is in the puzzle.

CHRISTOPHER TERMAN: It is. It is, and the doing of it.

SARAH HANSEN: And the doing of it.

CHRISTOPHER TERMAN: And I think that's great, because when students first come, they tend to be focusing on the answers. Here you gave me a bunch of-- a worksheet full of questions. So I looked at the answers. I think I'm good to go.

I say, no, the worksheets aren't because we want you to know the answers to those questions. The worksheets are to help you diagnose whether you understand things.

So the best thing that can happen with the worksheet is I don't know how to do this problem. And so I should go figure out how to do it. So if you're doing this self-paced mastery learning shtick, which is sort of how we try to help students master the material at their own pace, whenever they want to. So we have to provide a lot of self-assessments. They have to use them as assessments, though.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: They don't use them as assessments if they're just saying, oh, the answer's three to this question, and I hope they ask this one on the quiz. They're not getting it.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: Getting students to stop focusing on the answers and really focus on, how do I tackle this sort of problem?

SARAH HANSEN: Right.

CHRISTOPHER Of all the things I know how to do, I first have to select the appropriate concept or skill, and

TERMAN: then I have to know how to apply it.

It's sort of neat to watch them make the transition from coming in as sort of answer focused to leaving sort of like, OK, you can ask me anything, because I actually know how to do things from scratch, not because I just could pick something.

I can not only recognize the right answer when I see it. I can actually make right answers. That's a very-- people feel empowered when they can do that.

SARAH HANSEN: Let's talk a bit about the future. It seems like the courses is finely tuned already. But do you have ideas for how you might tweak it in the future?

CHRISTOPHER TERMAN: Well, I'm retiring in two weeks.

SARAH HANSEN: Oh, so not you.

CHRISTOPHER TERMAN: So it's being turned over to a new team. Some of the people who were part of the teaching cadre earlier are taking it over. They, of course, have their own strong opinions about better ways of doing things.

So I think that the basic structure of the course will be the same, the basic list of topics that will be taught. But they have a different sort of design experience in mind. So they'll find their own way.

It's interesting to me because I think until you've taught a 300-person course, you may not appreciate how things which work really well with two students in your office or 10 students in a recitation doesn't really work for 300 students. You suddenly say, well, they'll ask a question if they have one. So I don't need to be too specific.

It's sort of interesting to say, whoa, 300 questions. That's a lot of questions. And three of them from every student. So I have 1,000 questions this week.

And so you start learning how carefully the materials have to be prepared. In one of the questions you sent me, you talked about engineering the materials.

And a big class has a real issue with engineering materials that will help get students to do the things you want them to do, but you can't leave them adrift, because you only have so much capacity to pull them all back to shore. And so you really have to put most of what they need

into the materials.

SARAH HANSEN: Right. Can you say more about engineering the materials to keep everyone afloat?

CHRISTOPHER TERMAN: Well, so it's an iterative process. I mean, people say, oh, 004, it runs like clockwork. This is the best organized course I've ever had. And I say, well, 20 years ago you wouldn't have said that. We've had our share of unfortunate assignments, or undoable assignments, or assignments that were just too hard for some students, or too easy for everybody.

And so yes, we do that. We try to get student feedback. The forum is actually great for that. You get instant feedback on-- this sucked. And you're going, OK, OK.

And so if you're good, you make notes.

SARAH HANSEN: OK.

CHRISTOPHER TERMAN: I think I've taught this course-- I don't know-- 30 semesters.

SARAH HANSEN: Wow.

CHRISTOPHER TERMAN: So that gives you a lot of opportunity to think-- reflect at the end of each semester about what went right, what went wrong.

With a good staff, they're usually on top of it. Oh, we've got to change this, or I spent too much time helping students with this. And even in real-time we'll add a paragraph to the assignment saying, oh, a little bit more explanation, or a hint.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: So a willingness to sort of-- and think of building the materials as a continuous process. And after a while, most of the potholes are filled in, and the drive is pretty smooth.

SARAH HANSEN: Right.

CHRISTOPHER TERMAN: And sometimes the unexpected problem is actually a doorway actually into a whole new thing. We have some students that say, I thought about this, and I tried doing it this way. And I'm going, whoa, what a great insight that is. And so we want all the students to have that opportunity. So now we're going to figure out how to build that into the design problem so that

everybody has an opportunity to go aha.

And it was really neat that the students were able to come up with that themselves. But that gives you a viewpoint. It gives you an opportunity to understand how students are seeing what you're asking.

They misunderstood, so they answered a different question. And it turns out that different question was at least as interesting, or maybe even better than the one you asked. And so then you start one of these virtual cycles. Then slowly you build up stuff where you end up with questions that are really-- they don't look like there's much to them, but there's been a lot of evolution behind asking it just this way.

SARAH HANSEN: Interesting.

CHRISTOPHER TERMAN: And just this order. So it's been fun to go through that experience, and often surprising. And we go, oh, I thought it was so clear.