Big Picture Podcast – Episode 10

The Back Story (Chapter 6A)

Studying with a Rocket Engineer, Interview with Mike Lucas

For this backstory episode, we interview Mike Lucas, rocket engineer, on the nature of his work environment while collecting his expert study tips for the aspiring college student. Through our conversations, we stumble upon "Step 3 Learning", which involves synthesizing new information and solutions based upon a foundation of understanding laid down by Step 1 Learning (input) and Step 2 Learning (output) presented in earlier episodes. We explore how the college experience tends to focus on these first two steps. This can be grueling, but it sets the stage for a much more enjoyable career where Step 3 is the primary focus. Duration:30:19.

John: Welcome to the Big Picture podcast, we are here with Mike Lucas, a propulsion engineer working with the aerospace industry. Mike, thank you so much for joining us.

Mike: Yeah, it's great to be on.

John: Could you tell us a little bit about your work?

Mike: I've spent, I guess, seven years now in aerospace industry doing mostly. I guess the study of structures, how they act when you apply forces to them. And also how they vibrate when they're exposed to oscillating loads. And giving feedback to engineers to try to better design them so they could withstand all of the environments that they're going to face

John: Stresses.

Mike: Stresses. Yes, exactly. Stresses, displacements, fatigue, cracks. That's my bread and butter. Yes.

John: Aerospace, meaning airplanes.

Mike: No. So I work on the space side of the aerospace

John: Oh, cool.

Mike: Spectrum. Yes, exactly.

John: So you're looking at equipment that's going to be up in orbit around the planet.

Mike: Yes. Equipment that will be in orbit and also the equipment that helps it get there rockets is the number one and only way that humans have figured out how to get to space.

John: What a space elevator.

Mike: A space elevator that would require the form of very exotic engineering materials, which you'll often see headlines being touting as the next big thing. But I've heard quotes that say we have yet to build a footbridge out of these materials, much

John: Let

Mike: Less

John: Alone a space

Mike: A space

John: Elevator.

Mike: Elevator. So yeah. So while it is possible that yet, yes, you have the properties that are required and you know, a base material to build a space

John: It's

Mike: Elevator,

John: Elevator.

Mike: It's

John: It's.

Mike: Much different to actually build the, you know, thousands mile tall structure. You would need to get out to a geostationary orbit. Yes.

John: How about a transporter?

Mike: Transpark. Well, what

John: What

Mike: If

John: If

Mike: Someone

John: Someone.

Mike: Told you that the transporter worked, but the part that deleted you was malfunctioning? So they just needed to point the death ray. Actually, if you would just hold still for one second.

John: Mccoy was always frustrated, thinking he died every reborn, every time he was there.

Mike: Yeah. Who's to say?

John: You graduated from college 2012. Okay. Could you compare and contrast the amount of stuff you learned in college compared to the amount of stuff you've learned since college?

Mike: Well, I would definitely describe the things that a professional engineer needs to know. I sort of like a language and you need to understand the fundamentals of a language. Maybe before you kind of can expand on that.

John: Students come into the class and they Seavers speaking in English supposedly, but there are all these terms that this vocabulary that they're just not familiar with documentary Chemical Bond, Atom, a molecule, kinetic energy, potential energy. And you look at the glossary and you're like, there are a lot of new vocabulary here. What does each term mean? And one thing I try and emphasize is that it's the ideas are pretty basic, but they're new. Which means you need a new language for it. So people will often confuse the complexity of the ideas with it's just being a new language. If someone speaking French, you think, well, they must be really knowing something special and they're talking about how to order a hamburger.

Mike: Exactly. Yes. I mean. I like to think that you can only say that you truly understand a concept when you can explain it to someone who is not an expert in the field. That's that's kind of my my acid test and something that I very much enjoy doing because the way that I learn things. It's very frustrating because I feel like I read a lot of different sources and textbooks and jargon. And eventually I find those few key words which make the concept crystal clear to me. And it's this may be an illusion, but every time that I learn a new complex concept, I just think, you know, if someone had gone back and whispered like the two or three critical sentences that it takes to like explain the concepts as opposed to just the more jargony aspect that I find online, the core of a concept is almost always quite simple and can be explained. With very few words and very simple language.

John: That’s understanding?

Mike: Yes. Because things don't necessarily need to be complicated. Or if they appear complicated, that's only because it's a simple concept built on top of a bunch of other simple concepts.

John: We actually addressed this in an earlier episode when we're talking about the idea of Frame's frame being a mental construct in many ways it can sometimes be a filter that colors your world view in a frame is something that gets built in in one's head over time. And what we learned from there is that a frame is activated by words. So a few key words can activate this whole structure. So, for example, when you think tax relief, just those two words suddenly click a lot of conservative sort of framing that's in there. So that so it like turns on those two words, turn on this home network and then call it a frame in there. And so I think what you're alluding to similarly with you find a few key words that will activate much more than just those two key words. There's a bunch of an underlying structure that you're taking advantage of. If you if you just said tax relief to someone from another planet and they didn't have taxes, then it would make no sense.

Mike: You know, from from the person's perspective that understands how to play the board game. It's incredibly simple.

John: Yeah.

Mike: And

John: And

Mike: If anyone has ever

John: Her an interface with Facebook.

Mike: Or an interface, right. And

John: Yeah.

Mike: If anyone's ever tried to learn a board game, you know how frustrating it is.

John: When you were in college, could you describe your learning style?

John: Did you just dig into the textbook?

Mike: You

Mike: One thing that I always found was key was I would often, you know. The first step is basically the first up on the pyramid of knowledge is to listen, but it's very easy to be entertained and listen. And then the next step, which is kind of hard to do, is to write down what you're listening to. You know, that seems

John: Trivial.

Mike: Trivial step, but it actually is quite important, even if it's not nearly as pleasant as just sitting back and listening. That's very key. And then the next step one, you're learning on your own. You know, when you're in the library or in your dorm room or whatever, trying to get better at the concept that you heard, you might often read over your notes. And that's useful because you basically have translated what the professor has said and to something that makes sense to you. You know, like your own personal shorthand often. But. And then that's not quite enough. The next and I think the critical step, which is the hardest thing to do when you're preparing for an exam, is not just to breeze over your notes or the textbook and going, Oh, yes, I know that, I know that,

John: looks familiar.

Mike: Familiar. Exactly. I've read that a hundred times because I have literally read it a hundred times.

Mike: Try to try to work a new problem. That is incredibly difficult. And that is the true test as to whether or not you know something. And actually, I'll say that type of challenge is something that is uniquely difficult to college.

John: Mm hmm.

Mike: I I will say that is exceptionally hard, even as someone who has been working in the industry for several years during several challenging projects, thinking back to trying to work a problem from a college textbook is probably one of the unique challenges that I've faced. So if you find that difficult, good. You've reached the summit. I would say.

John: It's amazing that you are using the word step in an even earlier podcast, we refer to this as step one. Step two learning. Step one is where you're inputting the information. Step two is when you're outputting the information. That's it. Whatever you do, it's gonna be their input output. And the thing is, with input, you sit back and listen to a wonderful lecture or reading of really slick, smooth paragraph. Everything is like smooth as silk. You think you're ready. But as you're pointing out, that's not really the case until you've tried to output, as you said, writing it down or as you said, closing the book and trying to solve the problem on your own. So we call that step one. Step two, learning and am tickled is the word

Mike: Yeah.

John: Step.

Mike: Yeah.

John: Let me ask you, in terms of an industry where you're working. Do you see that application there as well in terms of step one step to take information and putting out the information?

Mike: It's certainly

John: Or is it

Mike: Less.

John: More problem

Mike: It's.

John: Solving?

Mike: It's certainly less clear, clear cut. I will say like in my role. On the spectrum of like pure practical, like turning and tightening bolts vs. coming up with new equations and theories, I'm probably maybe 70 percent of the way towards like coming up with new theories and only 30 percent of the way towards turning bolt. So what I'm trying to say is I'm. I myself am kind of edging more towards like the problem solving technical side of things. You know, I did that on purpose. I enjoy that type of stuff. But, you know, even for someone who leans that way, it is not as clear cut with the input and output is it is often kind of a gradual more trial and error. Like I will learn about a new concept. I will try to duplicate it on my own specific problem set or the tools that I have. Get an output that makes sense and refer back to the technical literature that I found. So it's I would say it's more of an organic process. And that's why I say I find that maybe a little bit more streamlined. It's a certainly a shallower learning slope on a day to day than it is in college. When you're faced with a brand new chapter of brand new topics and you're asked to work problems on it.

John: I think, Mike, you have just spelled out what we should call step 3.

Mike: Step three.

John: Whereas

Mike: Where's.

John: Step 1 and 2 is pulling in the information. And so it's incorporated into, let's say, your frame. But what you're talking about in terms of your daily work is synthesis and coming up with new ideas and problem solving to be able to do that. I would think you'd need a certainly a command of a lot of technical information that's slowly built upon over time. But you're saying you're the bulk of your daily tasks. Is is really more like what we might call Step 3, where you're synthesizing problem solving, using all that you the foundation that you learned applying.

Mike: Certainly the fun part of my job, yes. Yeah. And I will say that that third step. Synthesis, when I was first faced with that in my first college projects, you know, someone drawing on a whiteboard for eye for ideas, I can I can think back to it. And basically mentally rejecting it as just really unpalatable. It was just something that was like wild blue sky like, you know, wild blue sky. What are you doing out here? You know, there's so much more to learn. Why are we just going off on our own? And it was probably just cause I was intimidated by it, to be quite honest. But yeah, now it's it's something that just comes with experience. That's the that's the only way to put it. You know, now it's something where you can just look at a problem and immediately come up with a couple ideas and pointers. And it's really natural. But certainly before you have that experience, it's really scary. You know, if it's you know, if it's hard or challenging, maybe, too, we don't work. Work. The problem it's it's almost inconceivable to to think, you know, how can I expand the pool of knowledge? You know, like like who who am I

John: You're

Mike: To

John: Pushing

Mike: Do that?

John: The envelope.

Mike: Right. Yeah. Like like how am I qualified to do that? But I think it's the challenges that are going to move humanity forward are extremely broad. And they don't need to be maybe the most cutting edge ideas and they could still be very value added. That's very achievable for anybody, you know, given enough experience. And I guess maybe it was the most challenging thing at the time. But, you know, now it seems a bit more natural and certainly not as mentally tasking as, you know, go into the end of the chapter and working the problems.

John: Ok. Here we go. Step one tends to be passive. You can actually relax into it. You can get a false sense of security. And step two. Not many people want to do homework is an example of step 2. It's hard. You're having to put a lot of mental effort forward to really nail it down for that exam. You've got to do both. Step one, step two. Now, what you're pointing out here with step three. Whereas one might be comfortable. Step two might be difficult. Sounds to me you're saying that step 3 can actually be enjoyable.

Mike: Yeah, in fact, I would say step 3. It is always self-propelled. Almost by definition it is. If I were to hear this, you know, 10 years ago, me listening to me say this. It would they would maybe scare me off because it's so far from what I can conceive of myself. But, you know, truly it you know, as you gain a skill set, gain some depth, gain some breadth, when you seize upon a problem which, you know, like, hey, you know what, if I tried this and it could just be a small tweak of an existing tool. It will be entirely self-propelled.

Mike: This sort of thing doesn't come every day either. Obviously, you know what we're talking about, pretty pretty fundamental inspiration.

John: Would you say you're a rocket scientist?

Mike: I would say that no one would describe themselves as a scientist. In fact, where I am in, in fact, fun, fun fact, it is almost a derogatory term of a topic or exercise if it is deemed a science project. Because what? Because what that entails is that you are delving into something, which is.

John: Basic knowledge is supposed to apply

Mike: Yeah, Hower.

John: Technology.

Mike: Yeah, exactly, exactly like, you know, it would be a science project to figure out the sensitivities of this input to this broad array of outputs. We could go down that path.

John: Do you have a job to get done and that's to get a rocket into space?

Mike: Yes. And that's often described by the millions of subtasks that it takes to do. It could be funds do side projects, you know, like that kind of what I'm describing is that Step 3 can be deemed as a sort of science project, but typically it more means coming up with a new idea of how to do things faster.

John: We distinguish earlier on in the course the difference between science and technology technologies is applied to some purpose. Would you classify yourself as a rocket technologist?

Mike: I would classify myself as an engineer, I think

John: Mirror.

Mike: That's a very apt term, yes.

John: Oh, OK. So here, sort of a lead into the next question, your career requires a fair amount of technical expertise that you gain over time. I'm wondering about the social aspect of it in terms of working within a community of other engineers. How much of your job would you say relies on just the sheer technical and how much of your job relies on the sheer social?

Mike: This was described to me and I fully agree. So I'll repeat it here. But when you get to a certain spot and people especially, you know, people have been doing something for a while, often they've gotten good at what they do. Everyone gets the technical stuff. That is not what makes you special. Everyone is good at what they do, you know, to varying degrees of it. But it will be very difficult to differentiate yourself just knowing how to quote unquote, turn the crank. What makes you special is being able and what is in fact.

John: Or rather than especially mean valuable.

Mike: Valuable, I would say yes. Is to interact with others and collaborate and get something done. That's certainly the hardest part of my job. And I think that in college, you know, the Holy Grail was, you know, let's work on the most technical thing possible. That

was always kind of my goal and what I viewed as the most worthy challenge. And, you know, it was worthy because it was the greatest challenge. Right.

John: Let's.

Mike: Let's sled. Let's work on the most technical thing and anything that, you know, delved more towards the soft side of skills. I was not not dismissive of. But I thought I would put secondary. I would say now it has become increasingly clear that it is the soft skills. You know, the the hard skills will get you in the door and they will eventually come to you. It is the soft skills which are going to really propel you. And that's that's the lifelong challenge.

John: Well, I got to tell our listeners that today you took us on a tour

Mike: Yes.

John: Of your plant and I saw hundreds of people working together. Gosh, what a system. Each one a very critical cog in a very large machine.

Mike: Yeah.

John: I was very impressed in terms of how do these people work together on this same project. Wow.

Mike: I think what you were seeing was probably more on the production side because it was, you know, we were just from our location, we were on the shop floor and I would say, you know, that that does take a lot of collaboration in terms of safety and making sure that the best practices are being shared and communicated between the people assembling the hardware and those that are designing both the hardware and the process. The communication that I'm most familiar with is more of, hey, we have this set of requirements that were laid out in front of us. How do we best achieve that? Who do we need to work with? What is the scope of this challenge? Yeah, that's that's a bit more free flow. I would say that's that's a very difficult challenge. Yes.

John: How much math do you use on a daily basis?

Mike: I use quite a bit of math.

John: Is it mostly algebra or calculus?

Mike: I would say math is.

John: Arithmetic.

Mike: Rithmetic, I would say all of the above, actually, yeah. So I deal with vibrations a lot and a lot of times vibrations are you need to understand statistics. A lot of inputs are not what we call deterministic, as in we know the minimum and we know the maximum and we know the average. We know the general shape. The general frequencies at which they'll occur. But we don't know the exact cycles. So a lot of times you need to look at things through statistics. And so when you think about statistics, you're thinking about algebra, you're thinking about integration,

John: Integration standard

Mike: Deviation,

John: Deviations,

Mike: Standard deviations,

John: Ranges.

Mike: Derivatives. Also, I deal a lot with you often hear the term high power computing. That's kind of a keyword that you can look up, but it's basically using computers to solve physics problems. And what computers are really good at is what's called linear algebra. And that is not as I initially thought when I heard that term. The point slope form.

John: Y equals M X plus B

Mike: Y equals M X plus B. It's more matrices. So the vectors and groups of vectors aligned and multiplied by one

John: They

Mike: Another.

John: Add.

Mike: So mult yeah, it's basically computers. Almost every computer problem is just solving. You know, typically if you have two equations and two unknowns, you can solve them. What my bread and butter of my work is assembling a system of equations with a million equations and a million unknowns and solving for the unknowns.

John: To remind the listener what we're talking about here is a piece of metal that's going to be subjected to all sorts of forces

Mike: Temperatures,

John: In temperatures.

Mike: Vibrations, yes,

John: As

Mike: Yeah,

John: The rocket

Mike: Rocket.

John: Is taking off into outer space, is that piece of metal going into fatigue and break apart? What are the tolerances of that little piece of metal? We are talking with someone who looks into that

Mike: Yes,

John: Detail.

Mike: Exactly.

John: Wow.

Mike: Exactly.

John: Do you see yourself going into space within your lifetime?

Mike: Short answer, yes. Given sufficient advancement, it's really just a numbers problem. I think the current price that NASA is paying Russia to fly an astronaut is 80 million dollars.

John: Ok.

Mike: So,

John: There have been millionaires that have

Mike: Yes,

John: Purchased tickets.

Mike: Certainly,

John: Then

Mike: Certainly

John: Rate.

Mike: There's been probably close to 10 people that are just private citizens that are wealthy enough to buy a ticket and they out on the space station for a few days and then come back home. So it needs to be much cheaper than $80 million dollars, maybe something on the order of a once in a lifetime trip. You have to understand how much of a drastic change it would be to even have a $10000 ticket as opposed to a in 80 to 100 million dollar ticket.

John: Yeah.

Mike: Yes. So the other thing that needs to come down is right now, I think it's like on the order of like a like a 1 percent chance of death.

John: Safety.

Mike: Safety. Safety. Yeah, exactly. So.

John: This is an old question. As a society, why go into space? There's so much going on here on planet Earth that needs to be dealt with.

Mike: Well, that's kind of a default question, I guess I can play my role and give the default answer is that you cannot solve all problems before moving on to the next one. If that was the test given to any endeavor, nothing would ever get done. I think it's an entirely valid question as to whether or not someone should be forced to spend part of their paycheck to fund space exploration.

John: Well, look what satellites have done for us

Mike: Yes.

John: In

Mike: Yes.

John: Communications and for farming even.

Mike: Yes, and I guess if you play the what about Azm card, there are plenty of other things that we spend money on that are less worthy than space exploration, to be sure. But it's

John: But it's

Mike: Still.

John: Still a tiny, tiny, tiny fraction of other budgets, right?

Mike: Certainly, but I've seen a lot of these new space companies essentially grow themselves without needing direct and limited government funding. You know, the economy themselves has been able to propel them forward. Now, there

John: There

Mike: Are

John: Are

Mike: Always

John: Always.

Mike: Roles for governments in fundamental research. There's like a long history of that. These new space companies would not be where they are without the decades of NASA experience.

John: Mm hmm. So the public supports the private.

Mike: I personally would vote to spend a portion of my tax dollars to it, but I don't necessarily want to say

John: First,

Mike: That.

John: That to other

Mike: So

John: People.

Mike: That yeah, exactly.

John: So a bunch of students have an exam

Mike: Yes.

John: Coming up next week.

Mike: Yes.

John: What study advice might you have for them?

Mike: First start by going over the notes, preferrably notes that you have written.

John: Ok. Review the note.

Mike: Review the notes.

John: Not take notes

Mike: Take notes first

John: And

Mike: Up.

John: Then review the notes.

Mike: Distil the notes.

John: What you mean by distill?

Mike: I summarize my notes. That is that's a very effective. Yes. And then that is often what makes it into my, you know, crib sheet or a cheat sheet, which is

John: You

Mike: Used

John: Know,

Mike: For

John: You could

Mike: Testing

John: Take a note of

Mike: Of your

John: Your notes,

Mike: Notes.

John: Of your notes. Then eight, then eventually

Mike: Eventually.

John: You're gonna end up with those two three words that summarize

Mike: Maybe that's what I'm

John: The

Mike: Getting

John: Big

Mike: At.

John: Picture.

Mike: Yes, exactly. Exactly.

John: Uh.

Mike: That's what I can reference to reliably often work the new problems. Yeah. Preferrably previous exams.

John: Oh,

Mike: Yeah.

John: Ok.

Mike: Because, you know, oftentimes you'll get the textbook questions and then sometimes they'll be examples from old exams. That's super helpful.

John: So that's on the technical side. What about the students running into anxiety, you know, on the social side? What advice me have?

Mike: I have had like in like in the context of anxiety of taking an exam. So I have had my head spin.

John: Because it because if

Mike: If

John: You

Mike: You choke.

John: Choke.

Mike: Yeah. Oh,

John: Oh,

Mike: Yeah.

John: Yeah,

Mike: Choking

John: That's

Mike: Happens

John: For

Mike: For sure

John: Sure.

Mike: When

John: Yeah.

Mike: You're in the middle of an exam. This is something that I heard and I have done and it has helped me when I'm in the middle of an exam and I read the paragraph

John: Yeah.

Mike: And nothing, not a single word gets through. And I think I have thirty seven minutes left. This is one of my exams. This is going on my permanent record. It's going to affect my GPA. I think I may even get a zero on this exam. My life is over. Let me read the paragraph.

John: Try

Mike: We're going to try again.

John: Again.

Mike: I get stuck in that loop. What I find myself doing is, OK, I can understand this paragraph, but what I can do is I can just stop and get out of my head. And B, this is a chair. This is a notebook. This is a pencil. This is an exam. Here's the words on the page. Basically have to reboot my own brain.

John: Read them

Mike: But

John: The Michael

Mike: I

John: Lucas reboot brain method methodology.

Mike: Yeah, I have to start with basic. And I think all that that is is almost like a meditation to to like get me to like slow down, stop look at something

John: So

Mike: Else.

John: Something

Mike: Some.

John: Is choked again to the cerebral cortex. And this method here you're talking about is a way to release

Mike: Exactly.

John: That choke.

Mike: Whatever you could do to reset things

John: Deep

Mike: And often

John: Breath.

Mike: Thinking about consequences is not breathing exercises. You know, there's any number of ways. This is my own personal.

John: So because maybe the longer you're choking on that, the

Mike: Then

John: The,

Mike: Now you have thirty five minutes.

John: Uh, the choke becomes self-defeating.

Mike: Yes,

John: Yeah.

Mike: Exactly. Exactly. So it's good, it's it's rough. Fifty minutes. You know that it's not much time to take an exam.

John: I'm excited. Oh, we walked upon this idea. Let's call it a new idea, it's new to me. Step three, learning, which reclassifying as the synthesis of everything we've learned before. And it's it's exciting to hear about your detailed work within the aerospace industry. It sounds amazing. The love that you have for that and the social skills that are involved. How key that is. You said earlier struck me that the technical stuff or you call it the hard skills, they're going to come. Everyone will get those, especially you just doing it over and over again. It's going to come. But the soft skills are something that, gosh, sometimes you have to work on four because people changing teams switch. It's something you can work on throughout your career. Mike Lucas thank you so much for joining us here at the Big Picture podcast.

Mike: Oh, this is great. Thank you.

John: On behalf of all of us, good chemistry to you.

Mike: And you as well.

John: Our theme music by Zac Jeffrey. Musical flourishes by the Silent Boys from their “One Step Closer” album. Production assistance from Greg Simmons and CPro music. For show notes and more please visit ConceptualScience.com. A note of appreciation to all

instructors using Conceptual Academy. Thank you for your support. And to the hardworking student, our thanks to you as well, for your learning efforts, which we see as the path to making this world a better place. There's a bigger picture. That’s good chemistry. Good chemistry to you.