STD Session 8

**Karthik C:** [00:00:00] Right, that's the last class. Maybe two sessions I have to pack, I'll do it in the next, next session. Okay, I have to slightly pack two sessions today. Okay, so, Today, right? So since last week, right? All of, all of you, uh, remember snack analysis? Can somebody tell me what snack means? Stakeholder Huh?

Stakeholder need Stakeholder Alterable and constraints. Alterable Yes. All troubles and constraints, what are they? Anyone else? As usual, I will give marks for participation. Where is my Madhuri? Anyone? Fair, unfair. So, who are the stakeholders? Anyone who has a stake in the system? Right? Stake in the outcome of the system.

Correct? What are their needs? Is [00:01:00] it? Yeah. That is my part, yes. So let us say I have one extra number. One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen, fifteen, seventeen, eighteen, nineteen, nineteen, twenty, twenty one, twenty two, twenty one, So let us say I have this. So if you are interested in D to X, we are talking of a visual representations.

For any system to exist, right, it needs a purpose, correct? So if the purpose disappears, there is no point for the system to exist, right? Understand this. Got it? So, now, what is a system, right? Network theory next week I will cover, right? We will talk about what is the, uh, system, system already we have been talking about.

What is a system? What is a network? What is a system of systems? What differentiates, what actually defines a system? Right. What differentiates the system and the network, right? These things we'll see the next week, but for now, [00:02:00] right. All of you know, for a system to exist, it needs to have a purpose, right?

And you know a system has to have a boundary, correct? Correct. So it system has to have a boundary. It needs to, that boundary may be open or closed, right? You can control that. Right? Classroom. What is the boundary for the classroom, right? The physical. Physical boundary, right? The walls of the classroom.

What permits are. Prohibits entry the door. And I also told you boundary can be not physical. It can be in case of a compute network. It can be virtual, right? It can be a virtual boundary also. Right? So it, it's a little bit of abstract thing, but there is no physical boundary per per se in that case. What goes through s through a boundary, it can be energy matter or information because of a network compute network you've got.

Boundary which is in the form of a firewall or some restriction, right, that limits flow of information across the boundary if you please keep this in mind. Now, [00:03:00] any system to exist which meets the purpose there are a lot of stakeholders in a system right, if we take people at a massive system who are the stakeholders?

Faculty? Do you understand of an answer? Do not accept the crowd. Anyone? Any volunteers? Do not mark anything. Who are the stakeholders? Anyone? Faculties. You stand up and answer. Faculties. Okay, faculty. Then? Students. Who else? Yes. Students. Uh, students. Students, okay. Any, anything, any other non obvious stakeholder you tell me.

Security, yes. Non teaching staff, admin staff. Right? What's your own number? No, no. Wait, wait, wait. No. You can't speak. You can't speak. Okay. Non teaching staff. CS 23. B? B. B.

Yours, sir? I 1 0 1 4.[00:04:00]

Right, so, so we said there are a lot of stakeholders, some may be primary stakeholders and some secondary stakeholders. Somebody said security, right? So he's also a stakeholder. Correct. So who is a stakeholder or what is a stakeholder? Anybody who has a stake in the outcome. What is the whole purpose of the system, is to create graduate students, right, you have basically impart knowledge, correcta, right, and then keep churning the fields.

Now, to do that, right, lot of things are required. Understood? So, what are the things that can be altered in this system? So, we said S and N, stakeholder, and what are your needs? What is your primary need? You need to have a good classroom, correcta, needs to be quiet, right? And, uh, it needs to be comfortable, right, not to, uh, turn off the AC, right, not to save power, right.

What is the comfort, right? You need to have a teacher who is educated enough to teach you, right, and other [00:05:00] necessary resources. Correct? These are the needs. What are the secondary needs? Needs to have a playground, right? Needs to have some co curricular activity, right? Needs to have maybe, uh, sort of a, some sort of a culture where you can actually go build things.

You have clubs, right? Right. Your cultural clubs, your technical clubs, right. Other activities that are there. These are secondary needs. So needs depend on different stakeholders. As a student, your needs are different. As a faculty, my needs are different. Right. And as a non-teaching staff, their needs are different.

But we all have some common needs. Right? Right. A space to work, a place to sit, right? Right. You need, uh, somebody has to provide you food, so on and so forth. So what I'm trying to tell you is there needs to be an ally one. For a system to properly exist and survive, there needs to be alignment between the different stakeholders.

Right, understand that. So, if, why are you this late?[00:06:00]

Right. So, what I am trying to tell you is, right, you have got multiple stakeholders, their needs are different, and for them to, only if they have alignment, the system will survive. Right. I will give you an example. All of you went through COVID time, right. You were in your 10th standard back then. Probably nine Standard.

10 standard. 10 standard, right? 10 standard. Was it, was it a good experience sitting at home watching your computer and learning how many officer is good, sir? Sir, hands, why would you say, why do you think online education is better? 'cause you're in the comfort of the home first, and nobody's watching you.

Nobody to punish you. Correct. Now, legitimately, you tell me, yes, sir. We can learn at our own pace. Okay. So he's saying I can learn at my own pace. Okay then, but anyway. What is stopping you if you are physically here, which is not letting you learn at your own pace? Sir, sir, if I'm, like, like, if I'm at my home, I have my tablet with me.

I can, [00:07:00] I can, if I, if I don't understand a concept, for example. Okay, any teacher is going to be teaching instead of me physically here? But then, but then, but then the pace of the class is dependent on the others as well. Okay. So probably I might be, I might be below the average. Okay. So, the, it might not tailor the needs of mine.

Okay. See, what you are saying is okay. So, I can do the same thing now, yes or no. What is stopping me, right, or what is stopping you from actually doing something that actually aids in betterment of the academic activity? Got it. Just speak. So, think in those terms. I would argue, you staying in home is actually in a way detrimental, there are positives, I am not disputing what you are saying, yes, whatever you are saying has some merit, but overall if I see, [00:08:00] what is the first thing, you are at home, your mother may be watching or your grandmother, grandfather may be watching some TV news, right, first interference, you may have a younger sibling, they will come inside your room.

Sir, that is also dependent on self control, right, it is also dependent on the person. No, there are, if you have a dog, if you have, see there are disturbances now. Here I have a controlled environment. If somebody is sleeping, I know, I can see. Guys, listen. Right, next time I see somebody talking, I'll throw you.

Right. So, please understand this, right. So, I, it is much more controlled. You understand. This environment is much more controlled. Right. In that sense, right, again, you said, depends on the degree of self control. Yes. But again, there are other extraneous factors beyond your control. Suddenly there is a hawker selling something, right?

That is a disturbance. Or maybe there is a, uh, right? Maybe there is a, there is a temple nearby there that play a song. Anything is possible, right? So there are other disturbances that come in, [00:09:00] right? Which means, what is the purpose of your home? What is the purpose of your home? Shelter. Huh? Shelter. What are you saying, Badresh?

Shelter. Shelter, okay. You're also getting shelter. Love. Actually tell. What? Actually tell. Emotional support, okay. Parental support. Bro, love is the answer. Familiarity. Comfort zone. That's what you're saying. Love. What's your own number? Love. Two loves. Hi. 1060. Right. So, what he's saying is, what's your name?

Seshank. What Seshank is saying is, comfort zone. I'm in my comfort zone. My grandmother is there, my grandfather is there, my mother is there, father is there, my sister is there, right? So I, I'm in my comfort zone. The problem is, right, since you're in your comfort zone, learning becomes, will take second nature will take not second nature.

It'll take a backseat, just not know, right? So [00:10:00] the purpose of a home is different. The purpose of a academic institution is different. And if you put these two things, if you delete the boundary, what I say earlier, if you try to make. The entire thing into one system. Now if I am enlarging the boundary, am I not?

Right, virtually. Right? And the model has some difficulty. Right? So, why, why, why does it not work? This is the reason why it does not work. Because the purpose of a home is different. The purpose of a classroom is different. If we can bring about an alignment between these two, then it will be fine. Then it will work.

Right. There are certain, uh, Scandinavian cultures, right, where, uh, in Norway, Sweden or if you go, right, some students, like, remote, like, 300 kilometers, 400 kilometers away from each other. Right? Initially, they'll be taken to school, but for the majority of the year, right, school, school life, they'll be studying remotely.

I'm talking 10, 15 years back, not now, right? Only this, online learning is only picking up in India right now, last 4, 5 years. If you go to a place like Denmark, this is an [00:11:00] age old concept, right, 20 years back, right? As long, as, as long as you had internet, you had internet. Right. But we have always that.

There are also, uh, uh, children in U. S who do what is called homeschooling. Right. You never go to a school. Right? Your parents or you hire a special tutor to teach you. Right? That is also there. But then a positive and negative, but, but the key point which I'm trying to tell you is right, whenever there is no alignment of purpose between multiple systems, right, if there is a problem, right, then what happens is, right, your system will collapse.

Why? Why would it collapse? ? Because there is no alignment of purpose, and the purpose of a home is different, or a classroom is different purpose. So today we are going to talk, right? Continue into diagnosis. So far we are in discovery phase, right? So what did I tell you? When you talk about NPD, what is NPD?

New product development, right? You're making a new website, you're building a new car, right? You're creating a new platform, whatever, right? You're creating a product service or a product service system, right? You [00:12:00] do a discovery first. Right. Second thing is you do a diagnosis,

then you do a design, right? Finally, you do what is called deployment.

Right? Now the question is, this is the progression, right? The cycle will only, we've seen, right? Multiple times. I've shown you the new product life cycle, but value start. If I am starting from a blank slate, I will obviously start at the discovery phase. But, you are all CS graduates, right? Now, if you go to a company, where will you start?

Mostly, you will be in the deployment phase, actually. Which means, sir, why do, why should I even bother? That is the question you can ask, right? Why should I even bother with any of this? Because, I am, already I have a product, right? Anyway, it is there. Now, the question is, how do you make it better? How do you improve it?[00:13:00]

So, it is not just, it is not just that you are in the last phase, does not mean you cannot innovate, right. Simple example, all of you use net banking to some degree, right. How long have you been using net banking man, how long? Just give me some, 4 years, 5 years, last 4 years, 5 years. One year. Only last one year you are using now.

So, who has been using net banking for quite some time? 4 years, 5 years, can you raise your hand? Yes. DS will. Right. So those of you who are using it for quite some time is, does the interface stay the same? Alright. Every year ICIC keeps updating, go to spi. They keep updating Go IICC. Right. I've been using it for the last, I know, 20 years or so.

It's still the same. Right. They keep updating, they keep changing it, that website, but they keep up twice Google's homepage even though it has gone very little change. Right. You can see there are some right on. They went to that also. Right. Why do, why do they keep doing these changes? Right. If it [00:14:00] is already deployed.

So through deployment, right, you will understand many things. You will get to understand some deficiencies. Where, where is this not working? Right. Where is it failing? Right. Now we have a mobile first web development. Now anything you do, why? Because there are more people accessing internet through mobile phone than through a computer.

Earlier it used to be desktop first. Right. If I am building a website. So, the first thing we did was, basically we re enabled the website. First thing we did to, uh, what the CS team did, right, the website did that it was, check whether the thing works properly on a phone. How many of you are accessing MS Teams through phone?

Most of you. How many of you access through a desktop? Right? Not even half, right? Not even half. So, this is one of the reasons why when I get a mail, right, this might be repeated and it will get you multiple times. Even today I do not get a sub check. I get a blank mail, right. It is even worse. For, uh, from, from, uh, hostel students, right?

They'll send a leave application with nothing. [00:15:00] So they figure get a hundred minutes imagine scenario, right? So the thing thing is, right, in a desktop scenario, if you're building any app web development, right? Any app development, if it started with a web first motivation, right? What happens is it'll suffer, mobile will suffer.

Right? Now you have to build a website that's compatible with both, right? Initially, right? Think about the purpose of a website. If I am a web developer, what is my purpose? To build a website that will render properly on some, some browser, right, Firefox, whatever, right, Internet Explorer, right, on a desktop.

That is my purpose. Now what is happening slowly? A new medium is emerging, a mobile medium. Now what has happened, right? What is my purpose now? I say, I have to make it compatible with both. Somebody will use a tablet. Somebody will use a laptop. right Somebody might use, right? You understand, right? So, the medium that we use to access internet slowly does evolve, it does [00:16:00] add it.

Now what has happened to my purpose? It evolves. Where does it evolve in? It's, it's going from the deployment to the discovery phase. So the point I'm trying to tell you is, you can be anywhere in the process Most of the time, right? Either if you go join a company they'll put you in the design phase or mostly they'll put you in the deployment phase.

Very rarely, as a fresher, you might You will be allowed to go to the discovery phase. Because discovery, right, you really need to understand the product, right. People who have spent maybe 10, 15 years with a particular product, right. Even if you are skilled, right. For instance, right, my own sister's case I will tell you, right.

So, few clients, most clients are medical device companies, right. Philips, Siemens, Medtronic, right. Even within IT, there are people who do product development to one particular product, right. Why? Somebody who is working in banking, right. That fellow understands banking very well. Right? He understands that interface, that customer.

Got it? Now for a medical device company, who is the customer? Doctors and nurses. In case of a bank, it's the [00:17:00] public. Right? So, your stakeholder itself is different. Their needs are different. You understand? Right? So, just because I am in IIT, I have been for 20, 20 or 25 odd years. If I am in banking, sir, I know everything there is to know about banking.

Banking, I have done all the research. Right? I understand data structures. Now, let us look at the second case. from banking to medical device or medical device to IT, income tax, completely different. You really need to understand, right, different income tax rules, that constraint is different. You understand?

The constraints there are different. What are the things that can be altered? The reason I am giving you all these examples is because depending on the problem statement that you have at hand, all of these things will change, right. This is what we have been discussing in last class, slack, slack analysis, right.

So finally what is it I asked you to list down stakeholders, what are their needs, what are the alterables [00:18:00] and constraints. So I asked you to write 20 to 25 objectives to satisfy the needs of a particular stakeholder by all. By a, by altering a certain alterable within a given constraint. Remember that that template I gave you, right?

So you write out what you do. 25 objectives. Why are you doing this, sir? What is the point of doing this? The reason being right. When you do this right, you will take a step back from the solution space and get into problem space. What is this problem space. Can I get a new perspective to the problem? What is that you are doing right?

Why did. Gpay really got a hit. Why did Paytm got a hit? There was an ICICI app, right, 2010, 2012, right, it was in its infancy. I have to login, right, I have to remember that login password, mpin, dpin, right, transaction pin. I have to remember that. Next, I have to go, add a beneficiary, wait for it to get approved.

If I am setting 100 rupees, right, you understand this. If you are in this space, if you are stuck [00:19:00] with this, right, you write a snack, snack analysis for this scenario. Right. You are making an app to do internet banking. So, first, the first guy does it, right, he will be like, Okay, security is essential. I should not steal his money, he should not steal my money.

Okay. How do I bring in security? Which means I am going to put in a lot of multi authentication, right? I am going to do that. Second, which means I have to add, right, I have to know your bank number, I have to know your, uh, IFSC code, I have to know your, uh, branch code. Right. So many things I have to wait for the approval.

It will take 24 hours. Even if I have to send you 100 rupees, it will take me 24 hours to do that. This was the model. Right. They are in deployment. Somebody was doing, right, in banking doing this. If you ask that guy, innovate. What happens? Banks, every bank, right, Axis, ICICI, HTFC, SBI, they are all doing the same thing.

Now it takes an external guy, right. So Google comes up and says, wait. I don't know. So, you have to have the technology in place to do that [00:20:00] also. Got it? What is the technology, sir? Right? Every phone number now is linked to your bank. Right? That did not exist back then. Right? If you have a phone number, 99 percent sure it will be linked to your bank account.

Yes or no? All of your phone Paytm or your Gpay account. Correct? Now, the moment that happens, now your phone number becomes your identity. Right? That's your identity. Now, since that identity, I can actually use that to transfer money. I am just in deployment, I am seeing, right. What is it I am seeing? I am writing objectives, right, to solve.

Now this is a constraint, sir. Somebody is writing, right. Sir, this is a constraint. I have to wait 24 hours. That is a constraint. Right. I have to know all the details, right. I have to pester you. And it is not immediate. It is slow. Got it? When you write this down and when you actually take a step back and ask, how can I bring about innovation in this space?

Then you can actually know, okay. It is taking time. I need to pester you with a lot of questions. You have to answer and once I add, it's taking a little bit of time to actually add, [00:21:00] right? You understand? All this has to happen. How can I make it better? Can I just add one single information about you and instantly transfer money?

Would that even be possible? This is the question, right? All your payment apps, this is the question. Whoever did the development first, right? Now please read about the development of this, right? Payment apps, how did they evolve? Which means UPA, Unified Payment Interface, right? It's actually done by the Government of India.

Right? The backbone is them. BIM came first. B H I M. BIM came. How many of you use BIM? Nobody? You use BIM? Right? I started with BIM. So many problems. Right? The backbone BIM provides. Right? But UPA, back, back packets are certainly done by the Government. Right? They take care There is a regulatory body ensuring, right?

Your safety, all that. Now, next thing what happens is that Private comes in big deployment. They're saying and saying, ah, I can improve it. I can make it better here. Right? They have a snack analysis that tells them, right, these are the objectives that gives a fresh perspective for 'em. You [00:22:00] understand now through diagnosis, even though you are in the deployment phase, how can I actually build a new product, right?

Just by understanding the deficiency. That is the first thing I tell you. Whenever you are building, pick up your friend, right? Go wash your face and come. Right? So deficiency, once I see what is called gaps. So what you are doing, it is called the literature survey. What you are doing is literature survey.

What and all? Benchmarking. Right? Very important term you have to learn.

Right? You constantly do benchmarking. What is benchmarking? Ok, this is how I am doing it. What is my competitor doing? Are they doing anything better? How do they do it? Which means, they are streamlining. Right? I should also streamline. Right? I should also make things better. Right? I will come, I will come to this in the later part of the presentation.

Right levels of feedback Today, we'll throw a bit more like, right. What are the two kinds of feedback I taught you? Negative and positive. Positive and negative. How much of what? Which is preferred? [00:23:00] Negative. What is negative? Preferred. One at a time. One at a time. Stand up an answer. Stand up an answer, because I'm getting,

okay, so. So you know

this right, as you get older, your high frequency dies first. So I checked, my cutoff is 16 kilohertz, I cannot hear anything above 16 kilohertz. You can just go online, or you can go to Adacity. All of you know Adacity? Yeah. Right? Adacity, you guys use, right? Generate sine wave, wear headphones. Might keep the amplitude at one, right?

Maybe volume at 30, 40%. [00:24:00] Slowly increase the frequency, generate, sign, wave from what? Uh, 16 kilowatt 17. Start. Start from the highest at 20 kilowatts mostly you will not be able to hear. Only children. 10 here. So slowly. Keep going back. Every 500 kilo kilo. 500 hertz start at 2019. Point five 19. Mine, mine. I could barely hear something.

16 kilowatts 16. 16.5. Right. So number. V, 0, 0, 0, V, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0. Right, what you are saying is negative sir, negative feedback. No, that is not what I said, right. What I said negative feedback I will again revise, right. I know this will be the state after 3 weeks. Right, so I will revise. Ok, so feedback loops, there are cascading, are you guys familiar with the term cascading, what is cascading?

You create layers, even when you write software, right, you write it in layers, right? Domino effect. Simple example, you go to MATLAB, how many of you use MATLAB or Python, everybody uses Python, Python [00:25:00] scripting, you guys know, right? Now when you do, when you go to Python, if you want to compute sine of a function, what is the function you use?

Huh? Sine. Yes? Huh? Stand up and answer. If you are answering, stand up Yes. If you have to compute sine of a function, what is the Python, uh, Python, uh, instruction for it? Huh? Yes. Not sure, huh? You have to Google it? You've never tried it? Huh? Anyone? Nobody knows? np. sine. Yes. np. sine. Huh? numpy. sine. numpy, np. N Right?

So what you're saying is right. What's your wrong number? I 1 0 2 7 1 0 2 7 3 7, right? Yeah. So name, Harri Harri. Harri says NV dot sign, right? So I'm a [00:26:00] MATLAB user, right? So, but this is NV do sign. That's enough for me. Now I can actually go find a right. Gimme any number, any degree I can tell you what is the value of sign for that.

Right. So, this is a sub function, right? Sine, tan, cosine, whatever. This is a sub function. You are not actually finding the sign of it. Yes or no? Are you doing Pythagorean theorem and then dividing and then finding? You are not doing that, right? So, this is, there are multiple stacks. That is what I mean. When you write a code, you will call multiple functions.

Actually, when you are coding, all you are doing is calling functions. That is why you are not actually sitting and solving for each and every time. Correct. You write for any hydration, any loop that you write technically, you just do what? Just give it an index. And that's a, you increment, right? And you give a condition, right?

Dominating condition, right? But the loop itself there is something at the back end that [00:27:00] runs it, right? So it runs in layers, right? So there is another thing called cascading. What is cascading, right? Let's say you can only jump in. This is how much I can jump, but how do I come to first floor, right? So technically seeing, technically speaking, you are actually jumping little bit by using a staircase.

Yes or no? Right? So that is cascading, right? I cannot make one huge jump from here to here, right? First floor it is like four, five meters, right? In one single jump, right? Even if you call a basketball player, that fellow will not be able to jump. Then how do you get to this elevation? I can make multiple small jumps.

So what you do? Instead of jumping all at once, you put levels, jump to first step, second step, third step. That is the way to think. Now you understand cascading? This is cascading. Ok. Now in feedback loops, I will bring these principles, right, we will see, right. If you see half an hour I have been talking and I have not even moved [00:28:00] a slide, right.

Basically I am doing a revision of what we have covered so far and, right, I have set the stage for what I am going to talk about in the next class. Upcoming. Got it. Any questions so far? Now you know what? Who's a stakeholder? What are their needs? All triple constraint and the design loop, right? You can be anywhere with the loop.

Please understand. When you join a company, they will say, start with diagnostics. That, start with diagnosis. Start with design or start mostly, mostly 90% of the time you start deployment. They'll give you a webpage or a backend script and say, start with this, right? Understand this and try to innovate.

That is a question you'll be asked. So, let us start with today's class.

So, [00:29:00] now you see this, guys I hear some murmuring. So, diagnosing the system's ability to change. Why are we interested in system's ability to change? Right, we said, again if we go to class 3 and 4, for a system to survive it needs to, complex, it has to have good complexity, it needs to adapt, it needs to adapt to change.

Right, so for a systems to adapt, for a system to adapt to change it needs to have a complex, it needs to have complexity, good complexity, we will come back to that. Right, and you have this science of what is called cybernetics. What is cybernetics? It is the science of control and communication, I repeat, I repeat, note it down, it is the science of control and communication, right, man and machine, right, say right, Saibot.

So we will look at specific examples of it. Right.

Okay. This, we are [00:30:00] already familiar, right? So right. This the left, right? So feedback looks, we know there are rules of interaction. What are rules of interaction? There are multiple elements in the system. This is the boundary. So there is a stimulus that acts on the system. What is the stimulus? Now it's actually pretty hot here, right?

So I wore the wrong clothing, right? I wear, I wore full and shut thinking it's going to be cold. Right now that is a stimulus. What is the difference? My body temperature is going up. Same, right? What is the response that, that all, all of your sweating, right? It's pretty hot actually. Right? So what's happening?

Your response is you start sweating. You try to actually minimize your metabolism. I actually have to stand and walk means my metabolism cannot be, you are sitting. So your metabolism maybe be here. I'm actually moving about, right? So I'm also thinking as I'm talking to you, so I'm burning energy, which means I will generate lot more.

Right, which means the difference for me is higher. So obviously what is the response I have [00:31:00] to expect more to even maintain my body, right? So for this to happen, the system has to adapt, right? Watch your face and come mind flash. Shut down. Right? Watch your face now. Right? So system has to adapt, right? And there are rules of interaction.

What are rules of interaction between multiple elements? The relation can be on or off. Got it. So liquid on that, right? Sometimes. So these groups, right? Couple of, uh, practical examples that give you, right, we saw this, right? And you, and you and you, and we also saw any system needs to have what is called a purpose and purpose.

The definition we gave us a goal directed behavior, right? And feedback loop let be. That is with listen, right? So again, agree on rating. So there are feedback loops, there are multiple loops, multiple feedback loops, right? And if you take this loop, A, B, C. So, let us start with A. If [00:32:00] A increases, they are negatively correlated.

What happens to C? B will, B will decrease. They are negatively correlated, right? They are negatively related. So, B will decrease. B, C decreases, sorry. A increases, C will decrease. C decreases, it is negatively correlated to B. What will happen to B? B will increase. Right. So A goes up, sorry, A go. A increases, right?

C goes down because C goes down, B goes up because they're negatively linked, because B goes up, A will also go up. So with every subsequent cycle, what will happen, a will keep increasing again and again. So this we call deviance, amplifying. I repeat this behavior is called deviance deviation, standard deviation.

How much is it deviating from the norm? Right? So, this thing is called deviance amplifying. Is this a good thing or a bad thing? Right? Is this a good thing or a bad thing? Somebody is saying [00:33:00] bad. Who is saying bad? Yes. Is it bad? Why is it bad? Why do you think it is bad? It is going away from the set point.

Right? Is it always preferred or is it not preferred? This, specifically I gave you. Uh, let me read it into your memory.

Huh, I forgotten. What's your role number? 9 1 0 3 3 2 32.

What's your name? Right? Soia says it's a bad thing. Sir, what is the fundamental principle? Principle I taught you in engineering? There is no, there is no absolute good or absolute bad. Please understand. You cannot say This is good. This is bad. Why? Simple thing. I tell you. Friction is a good or a bad thing.

Depends. Uh, it's a necessary. It's a necessary. That's what we saw, right? That's what your textbook physics [00:34:00] says that it's a necessary. Why is it necessary and why is it even? Context dependent. Uh, even because who's answering?

Depends on the context. Right? It allows you to, what, roll number? Someone else also answer, who's that? You have to reveal yourself, otherwise I can't answer. Already wrote. Art part, right? So part says, right, it's a necessary, which is true. Now the thing is right, engineering option, good or bad, which means positive feedback.

There are some good things it'll push me away from the long. It'll not help maintain stability. It's this system. Now I'll ask you something. Is there, can you actually leverage these, these replacing. Okay. Sir, if I put a positive feedback, it actually resonates, it breaks bridges, right? Now think about the flip side.

What about the [00:35:00] construction industry? If you have to demolish a building, what is it I want? Resonance. I want resonance, right? I would actually, right? Nikola Tesla built a different kind of steam turbine, steam engine. Okay. It shook the entire building. Everybody was scared. They thought they had an earthquake.

Right? This fellow was sitting on the ground floor doing fiddling something. And then all the neighbors came running, they ran away thinking there is an earthquake. This fellow was fiddling with some contraption in his basement. So, which is, which is he was exploiting unintentionally. Ok, it was not his intention, he was, he was actually leveraging positive feedback.

So, positive feedback on its own, for most cases it is a bad idea, it is a bad thing. But, for instance, right, all of you have seen the LCS, the LCS circuit, In, remember this was there, right? Yeah. Right. All of you know, right. In radio communication, what happens there? Every subsequent, what happens? It grows and grows.

It amplifies, right? [00:36:00] So there positive feedback is preferred, right? I'm talking I, so there is a transmit that it has to transmit the signal, it has to amplify the signal. So I need a positive feedback there that if I keep cut the signal, you understand? I move away. I is equal to I naught into E pi minus T by R.

Proportionately, in the transmitter, right, your cell phone, how does it conserve battery? O is L by R. It is, more resistance is there. Right? Your cell phone is talking to multiple towers. If you actually read, right, network theory, right, how cell phones, right, there are zones, they will actually split it into hexagons.

Do you know that story? Have you read about this theory? Benzene, right? So, every tower, We are not circles, right? The model is not circles. propagates in a spherical fashion, right? So 2D, if you see, it should be circular, right? But if I model it like that, what happens? There are zones, but I get no signal, okay?

If I overlap, [00:37:00] you understand, there is too much overlap. So, for self worth, they will actually model it like this in a hexagon. But in practice, I can model all I want, but physics is physics. Physics will not wave. Your signal will not spread like a hexagon. But for modeling purposes, that is how I model it.

If I have to put a couple of cell phone towers, Oh, there's one here. Okay, I have to put another one based on this model, right? Not based on this model, got it? Now, for something like this, right, if the transmitter or the receiver, my phone is also a transmitter and a receiver, it is both, right? Okay. Signal that is right.

It has to estimate where the, how far this tower is. If I'm closer to the tower now what happens? It needs to throttle the signal. I needlessly, I'm sending a strong signal, right? See if there's a tower here, right? If I'm here, right? If I'm holding my phone right, I'm talking now it's going here. Now, if I'm far away, right?

If I'm somewhere [00:38:00] here right now, here, it has to increase the signals. Stronger so far, which means it does to move away from, which means the set point has to go up, right? So it'll actually switch between positive and negative feedback. That's the point I'm trying to make you understand. So set point have to move.

So which means with every subsequent cycle, I will actually let it go up. Ramp up, and other one, . Now I switch to negative feedback. In other words, I will dynamically be switching. Okay? If I move away. Right. I just took a positive feedback. I will actually make the deep, because what, it is deviance amplifying.

I want that, right. Once it has reached equilibrium, I will now switch to negative feedback. If I am sitting on negative feedback, right, it made a decent point. Got it clear, all of you clear right? Understand this whole thing very clear, right. Now right we spoke about this. And what [00:39:00] about this thing sir?

This is This will maintain equilibrium, right? It'll maintain what is called sta. It is self-regulation. It'll maintain a set point, right? If I, I'm negative feedback, setting a temperature at an air conditioner, it'll maintain, right? Join in negative feedback. Right? So what is the one quick thing I taught you?

Just by looking at the simple, if there are odd number of negatives, then it is a positive feedback. Sorry. Negative feedback. If there are even number of negative, citizen positive feedback, right? You can just count the number of negatives, right? Two, it is even. So it is positive feedback. How many negatives are there in this loop?

Only one. It is an odd number. So it is negative feedback. Understand that. Right? You can simply use that logic. You can simply look at, right? And you can say whether it is, or if you are not comfortable with that, use the logic what I taught you. Right? This goes up, that goes down. Right? You apply that logic.

Then you will know whether it is positive or negative. Right? This, you leave this. You do not do. Not relevant for us. Got this? Right? So, positive feedback is deviant, uh, deviants amplifying. Negative feedback [00:40:00] is self regulating. Right? Right. One more consequence of positive feedback. I'll tell you now. What about the education system?

Education system Is there, okay, what should it follow? Positive feedback or negative feedback? Negative. This is a standard, right? This is a model of education. All the students have to come to a classroom, right? So RI says, sir, I'm not comfortable with the system. I'll be comfortable. Uh, right? So what is he doing?

He's causing a disruption. Yes or no? Right? Now this, that disruption would negative feedback allow? Would it allow it? No right? Any, what did I say? Go back to the previous slide. Right, here. Any stimulus, what you are doing is a stimulus to the system to say, Sir, this is not working out, let's change, right.

What is the response, right. I [00:41:00] do not accept your thing, ok, which means So, um, uh, you see, I am just going to write a new one, just to show you. Bye. Otherwise reform will not be possible. You will be doing the same thing for 100 years, 200 years. Right? There is one guy called, uh, General Admiral Hopper. He says, The most dangerous sentence in the English language is, We've always done it this way.

Why are you doing it this way? Because that is the way we've been doing it. Right? Why is the education system, uh, why is it taught like this? Because this is how we've been doing it. Right? So that is a dangerous precedent. Why? Okay. That'll meet them. [00:42:00] So, if you have to bring about some disruption, right, to anything, the model, right, or anything that you want to change, you need what feedback?

You need positive feedback, right? So, in and of itself, it's not a bad thing. Positive feedback is not a bad thing, right? It has its uses, like everything else, right? Let's move on. Right? Again, right? This linkage we saw, right? Positive feedback is a very good thing. So, I am going to do a quick recap of what is the concept of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of a, of So these are, this is the, I think something wrong with this, [00:43:00] right?

So,

now, I told you, in any real system, right, you will have multiple feedback loops. There will not be one feedback loop, there will be not multiple, there will be hundreds or thousands of feedback loops that's happening in your body. What is happening? Right now all of us are at lunch, so you are digesting, right?

Which means as soon as you eat, right, acid has to be released into your stomach. That's a feedback loop. There are a lot of enzymes that are released from, from your, uh, uh, gallbladder, your liver, right? So many organs are at play. It's releasing a lot of enzymes, right? It has to digest. That's a feedback loop, right?

There is bacteria, gut bacteria in your intestine. That is, that, that will wake up. That will start actually digesting the food. That will, that will do its part, right? So, and as soon as you eat, you feel good. How come? You feel energized. How come? It takes 3 hours for [00:44:00] the digestion, right, for the thing to, whatever you eat to get converted to glucose and actually circulate in your body.

But how is that you actually feel better as soon as you are done eating it? How is that possible? Whatever is the stored fat, right, stored energy, now gets released as glucose. That reserve is what, is what makes you operate, right? So there is a feedback loop for that. This guy has eaten, released the stored energy.

Now, whatever is now will go to the reserve. So what you eat, you'll use it probably tomorrow, not today. Right? Understood? And if you are a bodybuilder, if you want to reduce weight, what do you do? Again, there is a feedback loop, right? You cut down what you eat, right? Then you work out, you burn more than you consume, which means you'll get thinner.

Right? Basic thermodynamics, right? So there are multiple feedback loops, right? So, what maintains the population of a country? Basic logic, right? All of us know this, right? So, birth rate goes up. Glycogen. Popul is increase. Right. And there are more people, more babies. Right. So it's a positive feedback, right?

What, [00:45:00] what Maintenance? A population death rate is also there, sir, for every two side bond we say a replacement pressure. If it is two, it'll maintain correct up. We say 2.1, right? Accounting for uh, right. It one or two children may die. Correct. And then we account for some losses also. So we say if a population has got a replacement ratio of 2.1, which means every 10 couples, if they have having children.

You see, that, sorry, not 11, 21 children, right? So, which means that that population will sustain, that is the logic, correct? Now, if the death rate, right, what is happening, right? Modern medicine is making everything better, correct? Now, which means, death rate is also going down, population will go up. Now, what is the only way to control population?

People are living longer, right? That has got its own cycle, or if more people die, right? There is a bubonic plague in, uh, Europe. Have you heard of it, bubonic plague? Lot of people died, right? You can see all the pictures. If you just put bubonic plague, right, there will be one guy with, uh, [00:46:00] what's that fellow's name?

Uh, western, uh, in the west they call him grim reaper. Have you heard of that fellow? Right, with the black hat, with the sickle, right? He will be killing people. So, you will see that pictures, right? So, people will die in like thousands, right? Hundreds of thousands, right? There will be a, in fact, right, historically speaking, hundreds So, historically speaking, right, the Mayans and Incas, right, when the Spanish, when they invaded, they were in America, right, they were the, right, the original, uh, Red Indians, right.

Their population was decimated. Why? These people from Europe, they went there, they carried the diseases. They were immune. The Europeans were immune to those diseases. The people in the new world, what the history calls the new world, they went there. Right, to places like Mexico, Paraguay, right, South America, all the, or Bolivia, all those places.

The native population was wiped out. Why? They were not used to these germs. Right, suddenly they bring [00:47:00] in a plague. They themselves are used to it because for thousands of years they are used to that. Now that wiped out that population. Right, so in that case, right, there is a, some stable population that is there in a Mayan or Indian civilization.

Say, some, suddenly some introduction of a new disease, right, by the invader. What, what, what happened? Right. It destroys the population of what happens. My fracture budget limits. Ultimately, it's a falling thing you cannot sustain, right? Ultimately, that's what happens, right? You understand this, right? So here we say, right?

This is the positive feedback. This is a negative feedback. Very simple thing, right? We look at more complicated cases right? Now, let's look at this, right? It takes several negative feedback loop to keep your human body stable. For instance, body temperature. What is the word I taught you? Homeostasis.

Stasis. Right? There is a set point. 98. 4 degree Fahrenheit. That's the temperature of my body. Temperature of all [00:48:00] of us. Right? And blood sugar has to be anywhere from 80 to 120. Right? Milligram per deciliter. Right? That's the thing. Now what maintains that? As soon as you eat, Right? As soon as you eat, what Yes.

Or you are hungry. You are hungry, what happens. Blood sugar level goes down. That is why people faint. They actually go into a coma. They are in a coma. People will carry a chocolate. Oh no, shit. Shame. If they are dizzy. Right, if they have a random d series, what happens? Go like 40, 15, really drop. So it means momentarily their body is unable to actually, right?

So you have your pancreas, right? That gives the lucco, right? So that breaks up the right glycogen in your liver that releases the blood [00:49:00] glucose. Now that brings up, which means your insulin has to be reduced. So the very thing, right, insulin is a lifesaver. But what happens if I inject myself with a big pile of insulin and I die?

Why? It will completely tell my body, Oh, this guy doesn't need blood glucose. Don't release it. Right? What will happen? Never. It will stop releasing. I will die. I will starve of energy. Right? So understand that. There is another feedback loop, right? What is the other one? You have eaten, right? Because you have eaten, right?

There is another feedback loop, right? When beta cells in your pancreas, again it says, Oh, this fellow has eaten. Let me release insulin. Which means blood cells take up more glucose, right, liver absorbs the glucose and stores it as fat, like glycogen, which actually brings the glucose level into control. So two things are happening, right.

There are two feedback loops, right. One we call hyperglycemic, which is what? High blood sugar, which is diabetes. [00:50:00] Hypoglycemic is what? Low blood sugar, right. Hypo, right, very low, right. Below 80 mg if it goes, again. That is a problem. So, what are we saying? We are saying, identifying and designing appropriate negative feedback loops to support biomechanics is a key principle in robotic self balancing, bicycles, etc.

How is it? I am able to stand. There is a negative feedback loop, right? There is a couple of bolts in my ear that tells the orientation, right? Even, even if I close my ear, first thing, right? So, my grandfather used to have vertigo. What is vertigo? That fellow cannot stand. If he stands, he will just do this.

Right. Somebody has to go catch him. He will be walking. Suddenly he will do this. Right. Why? Why does he do that? That natural equilibrium in his ear is messed up. It is ruined for whatever reason. Which means there is no signal telling him what is up or down. So if you go to a doctor, go to a doctor, he is a specialist.

If he wants to check whether your sense of balance is there, first thing he will ask you is walk in a straight line. Can you walk in a straight line like this? [00:51:00] Right. Second thing he will ask you to do is stand and close your eyes. And then if you have ventricle right, you will actually fall. Why? Once you close your eyes, one feedback loop is cut.

See your brain has compensatory mechanisms, right? There is one, there are two gyroscopes, right, in both of your eyes. That tells you whether I am looking this way, this way, whether I am upside down, right? Orientation, like your phone. Second feedback is your vision. So your eyes is saying, so you know what is the level.

That is a feedback loop. So there are two feedback loops stabilizing it. One is vision, right. There is a visual feedback and then there is an internal feedback. You understand? And then there is something called proprioception. All of you do this experiment for me. Before you do that, just listen to the instruction and then you do it.

Ok, don't poke your neighbour. Ok. What, what you want to do is close your eyes and then slowly raise your hands all the way and then you touch and then [00:52:00] bring it back. When you close your eyes If I do this, I know exactly where my fingertip is. Yes or no? You might not have thought of this. You will take this for granted.

How does your body know where your hands are? Even if I close my eyes, right? If you do this, I know exactly in space where my fingertip is. Where every part of my body is. Yes or no? You don't think about this normally. It is called proprioception. That is another feedback group. Ok. So there are multiple feedback groups even within your body.

Right. To maintain stability, there are two feedback loops. What are the two feedback loops? There is a visual feedback and then there is an internal feedback. Right. Now, if either of it gets messed up, one can somewhat compensate. Right. If, if, within a year, often, right, A and D, what happens is that, that bone, right, there is a fluid, right, that gets disturbed, right, if you have problem with the infection, ear infection.

When you go on a merry go round, merry go round, right, when you spin, what happens? You disturb the The ports get moved. That's why your head will be spinning, [00:53:00] right? No. Why does it happen? Have you ever thought of that? Right? So naturally it's like your, your phone. If you do this, what happens? You get into landscape if you do it very fast, right?

We will look at latency delay. The effect of delay, what will delay uc, right? That feedback, another important thing, right? No, don't delay, it's. What can latency bring about? Right? That's another headache. We have to deal with computer systems, right? So I'll finish this and I'll let you go for a break, right?

In computer systems, let's, how many people play games? Why you, uh, easily, uh, any girls? Do you, do you guys play any video games? Your, uh, like what is that? Uh,

valor ball. Yeah, that's the what I was looking for. Thank you. Yeah. Any of you Play ball. How many of you play? It's not a famous game, but say something. Huh? Huh? Temple Run. Every one of them [00:54:00] plays, but no one knows how to play. Subway Surfers. Huh? Subway Surfers. Huh? Subway Surfers. Subway Surfers, huh? Subway Surfers.

Subway Surfers, okay. Right? All of you play Subway Surfers. No, no, the point is this. Okay? Again. Guys, let us not go off topic. Right? See, think, Subway Surfers is not actually ideal for the discussion. I will tell you why. Okay. Or, right, I will take, I will give you two examples. Let us start with, uh, Ballarat.

Right? All of you at least have seen what the game is. Some fellow will be in, uh, Europe. Right? Some fellow is in Singapore and you are here in India. Geographically where are you? It is a network. And all of you are playing the same game. Right? Understand this. Think about this. Right? It is, this is something very vital and I, I will talk about zoom, uh, how, how does Google meet?

How do these things compensate? You have to actually look into the future. What the hell is looking into the future? I will explain. Okay. So, I am now looking at you. [00:55:00] Okay. You and I, we are playing. I am in India. You are in, let us say, Singapore. Okay. Physically, Singapore and India, we are like 3, 500, 4, 000 kilometers apart.

What is the communication between us? Internet, right? Okay. , how is the information travel, right? If I have A-A-D-S-L plus connection. Okay. A DSL two plus connection. First it's a telephone line, broadband line, which is copper. Copper goes to the local BS exchange. From there it'll be fiber optic cable. Okay.

And then fiber optic cable, all the way to that fellow local exchange in Singapore. And then it goes, or let's assume fiber optic, fiber optic, fiber optic, all of you know what network switches, there are gonna be a lot of switches, right? I don't have dedicated line. It's called P two P, P to P, right? So, I am, I am moving, so he is my enemy, I am his enemy, so I move to the right, in his computer, that will reflect after 40 milliseconds, that is the speed of light, right, even if I have a dedicated channel to him, speed of light is the constraint, so [00:56:00] if I move to the left, that fellow will see that after 40 milliseconds.

What is the response time of an average human being, roughly around 150 to 200 milliseconds, So, it is a very good, it is a very good latency, right? Now, let us say this guy is in US. Whatever you do, it is 200 milliseconds. Now what has happened? Latency itself is equal to my response time. And there are packets are going to drop.

It is not a dedicated collection. Routing is It's going to go through, jump through multiple hops. They call it hops. You can do trace route, right? If you go to command line and if you put google.com, right? Trace route, if you put, it'll actually show you how the communication is jumping between different nodes.

So in practice, between myself and him, let it is much higher. 2 53 and milliseconds will be the practical thing. How we able to play, right? Ping is the measure, the [00:57:00] ping is the measure, right? How are we able to play? How does the system compensate? This is example one, example two I take. I'm giving you online Excel.

Okay, this fellow may be in Bihar, you may be in UP, right, somebody may be in Chennai. Chennai 10 latency. What about somebody in Kashmir? Right, that is 3000 kilometers away, same problem, right, 150 200 milliseconds delay. But, when I ask a question, have you ever thought of it? When I ask a question, it appears as though we are talking to in real time.

We are not actually talking to us in real time, you understand? So, by the time you see me, I am talking something in real time. Right. Even though Eversource like right, sometimes there is a huge, what is called there is a huge latency, right? For whatever reason, huge packets get dropped. Right now the thing has to resend the packet, right?

It has to recommunicate. Now what happens? You are living in the past, right? You are not getting, now if you see Google, how it compensate sometimes, have you seen people will move very fast. Have you seen that? Right? That data [00:58:00] try to sink catch If there's a packet loss. It will buffer actually and it will try to re sync.

So, this is a way how most real time web applications handle latency. Got it? I am talking about a delay that is extremely small. Right? It is like one fifth of a second. Right? Now, okay, I will tell you practical problems. Okay? Somebody is submitting a leave letter very late. Okay? He comes to me. I am his faculty advisor.

I am in the classroom. This guy wants to go to security gate at 5 o'clock. He sends me now. I will go and take a look at what, 5 o'clock. Ok. What happens? I might approve at 5. Security will say I will not let you. Leave is not allowed. Right. This is a latency problem. Right. Like this, in practice I will tell you.

How this latency will cause lot of headaches, right, for any systems. And we are talking one feedback. There are thousands of feedback and that has, it is really messed up, right. You understand? [00:59:00] It is extremely complicated, right? That is why real time transactions like your NIFT, right? Your RTGS, all the backend systems, right?

If you read about it, right? The fund transfer mechanisms we have. Only small money they allow instantly. Why do they put a limit? Because if you have a lot of these things moving, right? Look at what has to happen. I am sending money to this guy. When I, in Google Pay, if I say 1000 rupees, I have to pay to, what is your name?

Huh? Prithik, I have to send 1000 rupees. Is my account active? Yes. Is his account active? Yes. Okay. Okay. Do I have money in my account? Yes. How much I want to send? Okay. Now my bank, let's say from SBI, that they just got with Indian Bank, it sends a command saying, are you ready to accept? What are we doing?

We are just changing numbers. In a ledger, we are just changing numbers, right? In his excel sheet, it's saying 1000. This will take a couple of seconds. Milliseconds like this. If there are close of request, it's flooding to Indian bank, [01:00:00] it's flooding to SPA. You understand what happened, right? And I have sent this for a thousand rupees, right?

Even before it is processed, I'm sending, uh, others another thousand rupees. I don't have it. All I have is thousand. So there is a query and it does not finish sending in the same time. If I send, what will the system do? Oh, it'll check again, a thousand pieces there. It'll send money, which is not there to that fellow you understand?

Have you thought of these things? Now, when you do big transactions, like 5 right? That is why it will not let you do it instantly because of the delay. Got it? You might think, why is this not going? In the back end, all the things, all the things happen. Please understand this. And sometimes when a, when you pay Amazon or Flipkart, for the refund to happen.

Why? It takes a long time, right? Google Pay, it takes sometimes 7 days to refund the money. Why? Because if it is messed up, money is deducted. That record I have. I have to go back and change the record. I have to ask that guy. Have you got it? No. Okay, that bank gives me a confirmation. [01:01:00] Done well. They will pool the money into a central and then they will send from there.

Now they have to tally that central account. That will take a lot of time. You understand? So you understand the importance of latency? Raise your hands if you don't follow. All of you understand, right? You don't follow, ah? Wake him up. So he does not even know why he raised his hand. Why did you raise your hands, man?

Please stand up. See, you actually self expose to yourself, stand up. This is a very interesting case. Why did I ask you? Okay, why did you raise your hand?

No, I said, who does not follow, you raise your hand. Did you not follow? Why did you raise your hand? Uh, No, you are looking down. Sit down. Right, uh, this you understand, right? So, this latency will cause lot of problems in networks. Right? Understand that. Similarly, By the time you eat, by the time it is released, there, there are single pathways, right?

They are reasonably fast [01:02:00] enough, so you do not have problem here as far as the human body goes. But when you talk about a large system, a big organization, right? Latency is a, it is a nightmare, right? So let us take, uh, 10 minutes, right? Time on my watch is 3. 05, right? Let us get back here in 3. 15.[01:03:00] [01:04:00]

I don't know. I think I've mentioned it, but I don't have the proper In the process. You're watching a movie, [01:05:00] I'm sorry, but I don't know what you're looking at. I just want to What's that? Do we take that with us? Sir. I signed that. I'm sorry.[01:06:00]

I don't want that.

I hate[01:07:00]

the.

How are you doing? First time I don't know you. I don't know you. I saw you both of you today. No, I have talked to you. I know you. I know you. You know, both of you are out of this. You talked to me. I talked to you. I know you. Right? Uh, uh, I'm sorry. What's your name, man? What are you doing?

Okay.[01:08:00]

I don't have one. So this is Joe. Yeah, yeah. Yeah. What's wrong with you? Who are you? What's wrong with you? Are you Dr. Dr. Brigham? Yes, I am. Are you Dr. Brigham? What the fuck? Since when have you been sleeping? I've been sleeping for a while. very much.[01:09:00]

Ah. Good morning. Bro, I'm so sleepy. What time did you sleep? Three. You should eat this, you won't feel sleepy. I've already eaten four. [01:10:00] You're still sleepy. I'm becoming immune, bro. I've already had four. Don't chew it. Yeah, I'm chewing it. So tell me, what time do you get up at night? Three o'clock. What time do you get up?

Five, five and a half. Why? I get up at six or eight o'clock. What a stupid schedule, man! I want to practice music. You've been practicing for 2 days and 6 months. Bad practice. I don't want to. How do you feel? I don't want to.[01:11:00]

Nice.[01:12:00]

After that, we will take a car and a, a. After that, we will take a car and a. Once they are ready to leave, we will take a car. Once we are ready, we will take a car. So start the car. Yes, that's right. I have to get out of there. [01:13:00] You know, I'm not stopping you. sir. sir. sir. sir.[01:14:00]

Okay. How many? [01:15:00] Four.[01:16:00] [01:17:00]

Okay. Uh, Four.

Okay. So, um, This is the um, I'm going to give you the transcript,[01:18:00]

Students, wake up. Wake up your labour. What happened, man? Why is everybody so tired? Students, wake up.

Sit, sit straight. Last row, sit straight. Say, I don't want anybody hunched. Sit, sit directly. See, if you start drooping, it's a problem. So, [01:19:00] sit straight. Sit straight. Sit straight. Right? So, let's continue with the class. Right? What's wrong, Madhu? Why is everybody sleeping? Plates. Plates. Plates. Plates. Plates.

Plates. Plates. Plates. Plates. Slap me, bro.

No, that is only a girl slap. No, I don't

actually. Yeah.

On your face.

So, we've been talking about feedback loops, right? As in any system has got multiple feedback loops. And, what is the key thing that I was discussing before the break? Latency, delay, right? We looked at examples of Exactly. Right, [01:20:00] RTGS, you are? Right. Money transfer systems, distal systems, distal payment systems.

We looked at internet banking. We looked at like how in games it can be a problem. We looked at online meetings, right, gmeetings. latency, right? So, we understand that, right, for feedback loops, these things are, Um, I see what you mean. What is this late, what is this pin? The pin thing goes to the extensor.

I'm obviously a bad writer. I will delete pins. No, don't. Okay, so. Right? Okay,

this, leave it as a assignment, right? For this take a look, right? So it talks about, right, multiple feedback loop, right? What? Water resource management, right? So there are a lot of [01:21:00] balancing and reinforcing loop and there are things that actually at it, right? How right? Based, what is generated, how it is purified, so on and so forth, right?

So recording. I'll explain a few more cases, right? Let us talk about this, right? What I was discussing at the start of the class, right, delay, how can delay have an impact, right, in the outcome. Delays and errors can make a system unstable. Why? Right. Another case study. Okay. So, there are two loops. One loop is talking about economic active, there are different economic activities that normally take place, right, in any system, in any country.

And then there is another loop which is spreading of the COVID virus, right. So this represents the COVID scenario. We'll start here. Okay. Let's start. A lot of people are getting COVID. Okay. Cases are going up. Positive or negative? What does the government action do? Government is taking a lot of [01:22:00] restriction.

Okay. Right? Government is intervening. Right? Once government starts intervening, what happens? People trust the government, right? Saying, okay, you have get vaccinated, right? All that. Now, once the trust in government goes up, what happens to the panic and fear? They say, okay, government is spraying, uh, pesticides, uh, uh, right, germicides, right, they are taking care of the sanitation, they are cleaning, right, people are getting disinfected, right, people are getting treated.

So, once, actually, people actually start believing the government innovates a bad thing, why? You will become relaxed, right? Which means the panic and fear will go, once the trust in goes up, panic and fear will go down, right? Once it goes down. So, what happens to your hygiene? They will be like, tsk, it is not spreading down.

It is under control. Right? Hygiene gets worse. Once hygiene gets worse, non infected population, right? Panic and fear goes down. Uh, sorry, trust goes up. Panic and fear goes down. Right? [01:23:00] Now what happens? Right? They are positively correlated. Hygiene practices, right? That is a mistake. This goes up, which means panic and fear has to go down.

Once this goes down, hygiene should be negative. Right? That is a mistake. Right? Hi. Practice will also go down, right? So, sorry. Sorry. Correct. What? Panic effect poster hygiene will go down once this goes down. What lab do the non-infected publish? Not lots of go down, right? They're positively correlated, which means the platform cases will go up and then you have what government has to do even more work, right?

So just hear what is happening just because there's a trust. That increases. You can see this feedback loop, right? Positively. It's positively cooperated, right? So speed of government action intervention. Also, they put a restriction on the economic activity. Businesses closed down, economic activity goes down, right?

Again, they're ly correlated, right? Which means speed of action also go down, right? So you see, how do you, so if I'm a policymaker, [01:24:00] right? The second question I have to ask is what, there is one side of health department. Health department will do what? I know to treat cases, sir. Why are you hesitate, man?

Right? Health department, what is the problem? There is one representative for the health department. Correct? That fellow has to represent this whole department. Right? Now, the health minister. Listen, listen. Right? Listen. Right. So, the health minister has to take a call, right? He has to talk over to the doctors, right?

The experts and he has to have his view. Right. I see. And then the economic minister will have to have his view. What is the view? If an economic activity stops also, a lot of people will die. Right? Some people will live on, like what? They'll be living on peanuts, right? They don't have reserve. So, the question is, how do you balance?

Right? So, it's a policy making decision. So, generally, that's, this is where, right, uh, government is actually, they'll find it very difficult. Right? If you're an administrative side, you have to balance both. Right? One side, I have to cut down the economic activity. [01:25:00] And also ensure nobody dies because of my intervention.

On the other side, if I don't do that, again, virus is spreading, right? It's like a catch 22 situation. What is a catch 22 situation? I have got a gun pointed at him, he's got a gun pointed at me. So I'm saying, you put the gun down. He says, no, I will not trust you, you put the gun down. What happens? Neither of us can, right?

It is just there, okay? So similarly, right, this is, uh, there is another case. It's called a Mexican standoff, right? There are three guys with each pointing gun at each other. It's a standoff. You cannot solve it. So, similarly, right? So there are, for a policy maker, there are a lot of these, right? Complexities, and I will not add the biggest problem, delay.

Right? By the time I take an action, by the time, right, I cut down, something else would have happened. Right? So how do you deal with it? Right.

[01:26:00] Okay. Right. So that's the central question. Now, multi-level feedback, right, for learning and adaptation, right? We have something called multi-level feedback, right? I mean, I'll quickly come to what this is. I told about cascading right at the beginning of the lecture today. What is that cascading? This is, this is the cascading, right?

What is that all about right now? What is that? You are taught? You are taught on how. How do you write a computer program? How do you build a data structure? How do you make something? That is all your thought, right? Precision and efficiency in goal seeking. That is all your thought. How do you make something good?

Right? Most man made machine interaction, automation is at this level, right? Robotics, right? It is at level one. There is a feedback loop, can you see? Right? At this stage, you know how to program, how to write a resume, how to handle an interview, how to present yourself. How do you make yourself better? You are at that level, which is a very bad level.[01:27:00]

Next level, focus on what? Now this is a slightly more mature level, bigger question. What are you doing? What are you doing? Right? So that is the question, which means I am doing this, right? On another level, if you go, right, this loop at a higher level, right, you can do what is called, focus on why are you doing this?

Why are you doing a CS degree? Right? Why are you here? Right. Then you are actually asking the question, can I repurpose, can I redefine my purpose? Right. So at one level, right, this feedback is on how, next level it is at what, it is on what, and at the higher level it is on why. Right. So look at what this guy is asking.

Right. Computer will simply do what a, what a human being tells it to do. Right. Now the computer is blaming this guy. Can't you do anything right? I am telling you what, what you are asking me to do. And this guy is saying, can't you do what I am telling, right, there is a discrepancy. Can you see that? That is why this picture is there.

Right, exactly what [01:28:00] this description. Dhanraj. Right. So, so multiple things, right, another case today I have put here. Right. Quickly summarize. Right. Guys wake up. Lot of you, I see lot of droopy faces. Right.

Okay. So, what are the things we saw so far? Feedback loops. Right post and negative and we start delaying and we looked at this life cycle, got it right where you start with discovery, diagnosis, design, and deployment. I told you most of the, most of you see as graduates will be here well on the deployment phase.

And don't think you cannot innovate because even through deployment you'll actually learn, help you actually discover a problem better and redesign and basically understand the problem better, right? So this is a beautiful example of. Let us look at England, ok. I am talking about 17th century England, right.

This is 1650, right, 1700, [01:29:00] ok, 300 years back. It is a cold place, England, it is a cold place. It is always raining there, right. Most of year it will be like this, it will be raining all the time, right. And it will be cold, minus 10, minus 20 degree, right. Very difficult to live. What is the fundamental need? We need to heat, ok.

How do you heat? Ok. Right. Since, uh, ever since. Right, man. Man discovered fire. Right? What do you do? You have to burn some wood, right? Which means what? I have to cut down trees. So when population was small, this was not a problem, right? You cut down trees, right? You put it in the sun, let it dry, and then you continue burning wood, right?

Timber, and then you get heating. No problem. But as the population grew, slowly what happens? More and more increase, were cut, and trees are also cut to do shipbuilding. And shipbuilding led to global trade, like Christopher Columbus is traveling, British, East India Company is coming to India, right, all this stuff is happening.

Coal is being imported into UK. UK goes to China, they understand there is something called ceramic, something called gun powder. [01:30:00] They take it from China. They come to India, they take lot of spices, all the storey. Right? Lot of spending, right? You import the raw material, get revenue. So government is now exaggera, is a lot, a lot of money which can, which means they can do even more deforestation.

It means more trees, right? I will be, I will build more ships. Right? Bhaskara Gama, look at any explorer. It was all government funded, every guy who left Europe, right, either in terms of, right, inquisition, right, trying to conquer some other land, right, to take Napoleon, it was all government funded, which means government needs to have money, money if I have to have, I need to have, I need to have something to sell it to you so you give me something, right, means I have to have something to offer you.

What is the British, what is the British, what could they possibly offer the Chinese? Chinese had more to offer than the British. It actually, they're buying so much tea. Apparently they were going back around. That is when they started the opium bars, right? They, they insulated them. Read good history, right?

That [01:31:00] is, that's what the British give to the Chinese, right? So you understand this group right now, the problem is this is all fine. Rain is going up, okay? Ship building is happening. People are, people are, they have wood in their home to, to heat. Now what happens to trees? Slowly there is deforestation. Now they understand if we continue at this rate, all the trees will be cut down.

We need to seek an alternative. Right? So somebody discovers, sir, there is corn. We found this thing black thing. Right? If you burn that, it's better than timber. It's color value is higher, right? And right. It's got a lot more power. Okay? Problem is what is the problem with coal? You have to go under, right?

It's not like I cannot chop down a tree and start. It is not that simple. Coal, you have to go mining. You have to drill. You have to go deep underground. Right? You have to gather all this. Then you have to burn them. That is the problem. Why? You are doing it by hand. Right? [01:32:00] Industrial Revolution has not happened.

We are still in Iron Age. Right? Iron and Bronze Age. Right? I still know, I know how to make knives. Right? Still, anaesthetic is not invented. Medicine is non existent. If you go to a dentist. Okay? Understand. Somebody is going to put your head. Do that. You want, you want to show me a gory picture? Right? How many of you cannot handle blood?

Okay, then I will not, I will refrain from showing you a picture. I will give you a picture. Not an actual thing, a drawing. All of you can handle it. Right? Sir, I watched Kill, sir. I watched Saw. The entire series. I watched Kill. Have you watched Kill? It's the most horrifying No, have you seen Saw? No. Series. I watched All of them.

Have you watched Have you watched People Die? Have you watched People Die in real? Yeah. Yeah, just [01:33:00] go to watchpeopledie. com In real? Yeah, in real. In real, in front of you? Oh no. Have you watched? I mean, I've seen the after The accident scene. I see you. I'm asking. Okay, guys. Listen. Right, before I talk about it, right, this is from another course.

But, this is equally applicable. Make, make, make a note of what I'm saying. These are generic, generic principles, right? For a designer, for an engineer, this is important. Don't be a slave to it. Today, Python is happening, right? It's a happening thing. Correct? Yes. My age, right? My time it was C, C sharp. It was not even C Either C, C sharp, or if you knew Java, you are like, uh, Lakbhati.

You'll get a, you'll easily get 70, 000, 80, 000. Right? If you knew computers, see, [01:34:00] first time I touched internet, right? If I recollect correctly, right, it was in 2002, 22 years back, right? That's the first time I actually went to rediff. com, created my first mainnet. Right? Nobody knows Rediff, right? Right?

Nobody uses Rediff, right? Sorry that Google meant, Yahoo is also dead, right? Or you might use, right? Outlook, right? Microsoft, Microsoft. So, back then, if you knew, okay, it's not a joke. If you knew PowerPoint, if you knew Excel, if you knew Microsoft Office, you can find a job for 25, 30, 000 rupees. Just knowing MS Office.

What is the major difference between Java and MS Office? All of you can work on it, right? Which means if you were, if you are back then, you could find employment if you only knew MS Office. That's it. Nothing else. If you knew C, Java and if you can do the scripting, 50, 000, 60, 000, and you go, you can become a teacher, teach these things.

Okay? It was like, it was happening to everybody. Okay? What is the [01:35:00] problem? Slowly new tools. Look at Adobe. you Adobe Flash, right? Adobe Flash is like a extremely successful, right? All the web development happened. Now HTML5 came, and then what happened? Two years. Now, gone. All the websites which are built in Flash, scrap.

Right? Some websites they ported to support HTML5, whatever stuck with Flash, now Flash is no longer supported. Dead. So if you could build macromedia, right? There were special lessons in NAIT where you have to pay one 1. 5 lakhs It is easy to learn Flash on a very deep level. So, if I knew Flash 20 years back, I can sit and earn money like anything, today it is not the case.

Can you say what will happen in 5 years time? Nobody can, right? The change is so fast, right? It is unbelievable. So, what is the first thing, don't be a slave to a tool, learn a tool, nothing wrong. Learn programming, somebody can always it sell, I can't say if it is there or not. Lock and Paste it, ok? It has made your life easier.[01:36:00]

Right. What, it took you to go to github, copy paste, right, that time it has cut down. But still if you have to debug, you have to debug. Some basic code if you just put, uh, I give you 5 to, uh, sort it. Beautifully it will give you. Let us get it more complicated. Right. You can, maybe, say, you write a piece of code where you take in inputs from n number of people and, and you have to create a database in C.

It will do. Right? But if you give it, can you give it a real application and say, can you debug why my IRCDC website is not working? You need a human being to do that, right, at any point in time. Right? That's, that's like, he's written 15 years of him, and it can actually go on and on, right? Really understand that.

That level of intelligence it is not there. Right? There is one professor in, uh, in, right? His name is called Michio Kaku. What he says is, today's robotics, right, today's AI and ML is at the level of a cockroach. The intelligence is like a cockroach. Why? If you put, [01:37:00] what he says is if you put a robot, today, into a forest, it cannot even survive.

What is the first thing? It has to protect itself, right? It needs to find it's way, it needs to charge itself, it needs to somehow, seek a source of energy and protect itself. Today's robots cannot do that. Right? So it is got intelligence of an insect, at best. Right? So understand. So first thing is, don't be a slave.

Right? Next thing. A tool is only as good as the person who is using it. Yes or no? This is obvious, right? Right? Perspective, right? This, I have already emphasized this, right? In this book, right? Change your thinking and yes, I have spoken. And sharpen the soft, probably, right? This I might have spoken in the beginning of the class.

If I give you 5 hours or if I give you an hour to do a job, For 40 to 50 minutes, you should actually sit and then sharpen the saw. What do you mean by sharpening the saw? If you, if you take a blunt saw, right, blunt axe, if I start chopping a tree, what will happen? I can put in all the effort I want. It's blunt, it will not do any job.

Rather, if I sit, sharpen it, four, five cuts, [01:38:00] strategically I can cut, and then do what? I can cut down a tree, right? So that's the thing. Right? Now. Next. Right? Magic. Yeah, I think that's it. We'll see. Ha, ha, ha, ha. Okay, so this is the question I ask, right, as a medicine, so generally I say yes or no, right. Look at this.

This is what, this is exactly what I wanted to show you. Look at this fellow. He is a soldier. He is injured in battle. What is, he is a doctor. Look at what is he doing. He is taking a hacksaw and he is chopping. No anesthesia, no antiseptic, nothing. They have put a cover over his thing and he has to bear the pain, right.

This was the case 300 400 years back. We can just exit the presentation, right? Right, the reason why I showed you this, right, right, [01:39:00] the reason why I showed you, all of you saw that picture, right, this is where, this is what we are talking about. Oh, it is not coming. Duplicate it, yeah. So just duplicate it.

Right? You understand this? This is where, this is the time I am talking about. No anesthesia, no antiseptic, nothing. Why is the doctor chopping? That question you have to ask, right? Huh? Right? It is called gangrene. What is gangrene? He said infection. He is correct. Right? I get a bullet wound. What happens? I am bleeding.

So, they will tie and then wash. The wound itself is not going to kill me. Now, wound is going to cause an infection and that is going to give what is called sepsis, right, and that will actually eventually kill. So, they did not know how to handle it, right, they did not have any antibiotics, bacteria as their viruses that is going to mess up, that is going to enter my body, right.

Ultimately, I lose the [01:40:00] limb, I lose the entire system and it will kill the whole thing. So, only way to save the patient back then is amputation. Oh, you got shot in the leg, leg is gone. Can you imagine that scenario, right? So, this was the time. Fine. Which means they were very crude. They only had very basic things like iron, steel.

Steel was not even properly perfected. They had iron, of course they had copper, brass and bronze. That's it. Right. So this is the time. Now I have to do mining. Now have any of you seen mining, any mining videos? Guys, completely covered. Children actually, 10 year old children, right? In England they used to do this, right?

4 children, they will be sent to the mines. They will, like small boys, right? 9 10 year old boys, they will be asked to go. You will die, right? So why? It is damp, right? It is dark. You will have powdery coal, right? And you have to do it by hand. There is no other way. You have to physically move the thing, right?

So coal mining was a painful activity, ok? [01:41:00] But it's a It is like black gold, right? So I get gold, I can burn it, right? It runs much cleaner, right? Easily catches fire, right? Like wood, right? I do not have to struggle. But the problem is when you dig, what happens? Especially in a place where it rains a lot.

You will get, you will get water, right? Which means what? I have to somehow pump the water, right? So that is when James Watt, right? He perfects, right? James Watt did not invent the steam engine, right? Steam engine, Lycoming, right? He makes the engine huge. inefficient. What it want to, right? He did this, right?

I am going to talk about feedback and I'll get there. Right? So, what is happening here is people are doing mining of coal by hand with very primitive equipment. Right? Have you seen the lantern? They didn't even have a battery, right? All the 3M stuff that you find today, they don't have, they didn't have that.

Right? There was no mask, you just tie a piece of cloth. Done. That's your mask. Right? No gloves. Right? No proper boots. No proper clothing. Jeans. It is a [01:42:00] special case, a case where you are printing a gene. It is a special case, uh, uh, You are printing a special kind of gene. You are printing a good tasted gene, but you are printing a bad tasted gene.

So, you have to realize that there is an important distinction between what is a gene and what is a problem. You can read about it in the book. Right, you will be happy. Now the point is, right, I have been to the places that make jeans. Ok. Guys listen, this is a very interesting thing. Usually when they make shirts, right, and other apparel, they have to have very fine cotton.

Ok. They will do, right, I forgot the process, right, there will be a thing like this that will be doing. Process. Right. It'll be doing, you put cotton, there'll be like a log and of a thing, right? It'll be doing this in separate the fineing fibers, right. You buy a Raymond shirt, right? Right. It'll be very comfortable to wear, right?

Right. It's [01:43:00] 2000 piece. 3000 piece, so you can also buy a shirt to fire piece. Also, it'll be very coarse, right? Have you seen, right, you buy a shirt for T-shirt, right? If you buy a T-shirt for 300 piece from Amazon, it'll be very course right , if you spend a bit more money. You are going to get a much more softer cloth, why?

The fiber that goes in, right, it is a much finer fiber, right? So cotton, the fiber has got different grades. So the worst grade of cotton goes to make your threads. Otherwise, that which is discarded. After I do the, uh, refining, right, after I take out the best fiber, the worst fibers I have, the roughest fiber that I have, the mining people, they said, if I wear normal trousers, my job, I am rubbing everywhere.

Right? You, let us make trousers out of the worst, the coarsest cotton, I should not say worst I should say the coarsest, right. They made clothing out of it, pants out of it. What happened? That is your jeans. Over time, US took a product, they are very good at marketing, they convinced all of us, right, it is worth paying 2000.

Actually, what [01:44:00] you are paying is for the worst possible grade of cotton, right. Of course, nowadays you get like very soft jeans also, right. So again, that is a finely graded thing. But understand this, right, marketing, follow up, right, just as a spin off. Now, come back to what I was talking, right, understand G, right, understand coal.

Now, this is the scenario, right. Guys, listen. So, I am doing coal mining, right, when I say Ayanami. People back then, they are doing coal mining, right. This is the, the condition, right. They cannot breathe, they cannot see, right. And there is water. It is always flooding. Now, I need a pump to pump out the water.

Right. Steam engine, all of you know the principle, right? What, what happens in a steam engine? You want gone turn steam or water in the steam. That steam pushes a piston. That rotates a flywheel. How you get, you can do anything you want. You can run a automobile with it. You can run a train with it. You can move a machinery, you can run a sewing machine with it, right?

Anything you can move anything that needs a horse or a right, anything, [01:45:00] right? Anything you need, you have a thing or a horse animal driven thing, you can have. Right now there is a feedback loop. You see they're doing coal mining where naturally water will come. That water is also required for steam power.

Understood. Now, that is actually a good thing for me. Water is bad as a byproduct. Something unintended. I don't want water when I'm doing mining, but I get it. I get it anyway. So what I do, I use that water to power the machine that actually helps me to excavate faster. So what happens? That is a feedback.

Right. So steam power happens now that pizza extraction now that helps you grow, make steam, which is what makes all this possible, is building all this. So you see, we went from using wood as a power source to using coal exploration led to a lot of problems. The problem itself was actually a necessary requirement for steam power.[01:46:00]

Right? Now comes another problem. Okay sir, we have solved all this. Now we can mine coal, we can pump water with the steam engine, right? That water itself is used to run the steam engine. Now I have everything, everything is muck up, right, properly into each other. Now the question is how do I regulate this?

How do I control the speed of the engine? Right? I want it to constantly run at a set RPM. Right? How do I govern? G O V E R. Governing. Governance. Right? That's where the word comes from. Please understand. Government. Right? How do you govern? How do I g o v e n c e in proper order? In other words, in this case, how do I build a governor?

So, in economic terms, you have got R D A governor. You've got R D A governor of Tamil Nadu. You've got R D A governor of Pondicherry. You have all these governors. Governing means what? Right? It means different things in different contexts. So if you look at here, what, what is James what? Right? Understand right?

Right? W A T T means right name of a [01:47:00] person. It's like what's your name? Sanket, speak governor if I say all of you will laugh. Right? If I say Seshank, speak governor, or if I say, man I keep forgetting your name. Badresh. Badresh, yeah. The problem is Badresh. I have to say your names. See other classes I do, I do.

That's not great. So I remember here, there is a three big breaks, so I forgot your name, right? So re speak, . It looks funny, right? It looks awkward, actually. Yes, right. It looks awkward, right? Understand that. Right? So understand that. Now what happens is, right, I have to have a set point, right? What is the set point?

By the, I'm not, it's natural. I'm not, I don't have an inclination to fight him. Don't.

So, I have a set point, right. So, what is the set point? This engine has to [01:48:00] look at the fan. It is running at a set point, right. I, I, I keep a certain speed and it is able to maintain that speed, right. How is it able to do that? I will give you another example. Electricity, what is the frequency? Frequency of mains power?

60 hertz? It is 50 hertz. 60 hertz. So, the basic concept is that when I say a line I need the correction, and the first thing I should do is a correction. So, I don't need a translation, I need a correction, so the correction I need is just one line, I should just have one line. Why 50? All your electrical devices are designed to run at 50 if there is a frequency deviation.

And this is gone. In fact, if it is so good, you can actually use it as a reference to calculate. One second. How do you cal calculate the [01:49:00] position area? One second. One second. 50 hertz, man. So if a measure 50, if a measure how many times it's changing Hundred times, right? It clause zero, one second has cannot build a clock with it.

So all you have to do is make a circuit that counts the main frequency and build a clock with it. Because that is why reference, right? What is one second? Can you say one second without looking at your watch? What is one second? You cannot write. You need a reference, right? So, you can use that as a reference, right?

This uses a quartz crystal for a reference,

I have to run it at a set frequency. Right? Wash your face and come back. Right? I have to run it at a set frequency or at a set speed. Right? What can be done? There can be one guy, [01:50:00] right, looking at the speed and saying, oh, it is going faster. Let me reduce the speed. Oh, it is going slower. Let me increase the speed.

You understand? Just like how your pancreas is able to release insulin, right, at a varying level, right? If I eat more, if I eat more sugar, what happens? It has to increase more, more insulin. It has to release. If it less sugar, it reduces your according, right? But here, what does it do? It has to happen automatically.

How does an automatic thing happen? It's because of this arrangement, right? It's called a wat been governor, right? What happens is, right, this spins, it spins. These, fly these, uh, governor thing called a governor. The cent will actually rise when it rises, right? Because the faster you spend, the more it'll rise, the more it raises, right?

You have this linkage. You see this lever, that will actually move a valve, it will open and close a valve, right? If the engine speed gets too fast, what happens? This will also spin, right? And the flywheel will actually, the flyweights, right, it will move much farther apart, which means it is [01:51:00] going to pull this lever up, which means it will pull this, it will actually close the valve.

So if the engine speed goes up, what happens, right, the speed at which it revolves goes up, right? And then there is a mechanical arrangement. That pulls the, that closes the valve, just like how you would open and close that tap, right? That's what this, this thing is doing. When it's slow down, what happens?

This weights drop and it'll open the valve. You understand? Is this not negative feedback? So just by, and it is automated. I don't have to touch it, right? Just by selecting the weight and this linkage geometry, UCDH, right? Don't worry about any of that, right? So just by change the linkage geometry and selecting the weight of the right.

Fly masses. Right? I can actually see, see, it's here. It's a small part of the whole thing. So it's a, it's, it's a, it's like a, B, C, D, whatever, a, B, C I'm showing you. This is one thing. This is A, B, c, there's a . Right. Each talk to each other. [01:52:00] Got it. Right. So that is an example of negative feedback loop that actually maintains a set point.

Right. It is deviance reducing, is it? Right. So. Let us recap this picture, right. This summarizes everything we have to understand, right. What is that we understood so far? Mostly in engineering systems negative feedback is good. There are occasions where positive feedback is also good. Positive feedback is deviance amplifying and positive feedback is good for systems where you want to innovate.

Others, you'll just stick to the same thing. Right here. We looked at deforestation, how uh, uh, plants, the trees are cut down for heating and then they found coal. In finding coal. They found water, which is a problem. They actually build steam engine, which actually uses this water, right? So there are multiple feedback loop here, right?

So, right. So last slide. Right now, what is this? Any of you seen this? [01:53:00] Any of you seen this picture? Right. Read about it. It is an interesting implementation. Right. So, MIT, they did a prototype like this. Right. It was an innovative idea. Right. What they did is, it is called a soft rock jet. Just Google this.

You will get this. Right. So, what is that, uh, that I am saying here? Innovative solutions designs can emerge by adding new linkages that connect unique elements in the context through negative or positive connections. Right. Have you heard of this thing called Group Per Goldberg machine? How many of you heard this term group per Goldberg machine, right?

Somebody is racing stand. Stand . One way, write it down for you hand. You have erect dysfunction. Okay?

There is this guy called Berg. Okay? Have you seen the whole ad? Ages back, [01:54:00] right? There's a Honda ad, right? Where they took parts of a Honda and give them, and I'll show you the actual video. Is it connected to the internet? Oh, yeah, yeah, yeah. So, it will, everything will be there. So, uh, there's the probe.

Everything from the exhaust to the engine will be in the downy of the probe. Okay. Help me, Dad. With what? Everything in your life is sorted. My ass. Is sorted. No. You use, you use PicsArt very often. PicsArt is used by your ex girlfriend. You use it loudly. Space competition is too much, sir. Too much. Too much space.

Hey, this is what I'm talking. You okay? [01:55:00] There is no audio, but it's still fine.

See, all these are parts of aka. Okay.

Do you see the silence? Uh, that's the windshield. These are the valves of the engine. 3L. 3L Gold. Inertia'd, uh.

It's fiction. It's enough for him to go to the police, but 3L ain't coming to that. Yeah. 3L. 3L. 3L, uh, They bought a bullet. Adi, he's a skill issue boy. So[01:56:00]

they shot the entire thing in one go. I don't know how many tries they took. It's

not graphics, man. It's done. It's done with physical things, yeah. It's not graphics. It's done. This ad is 15 20 years old.

That's your wiper, actually.

See, all the pictures, it's on another card.

This was the ad for, [01:57:00] uh, So,

similarly, you see, okay, what is this guy doing? He just wants to wipe his face. So, he is eating, he is pulling a string, he throws a cracker to this, uh, parrot, right, parakeet. Once that fellow grabs it, weight goes higher, right, that puts some bird feed, right, that pulls this, that fires the rocket, that cuts this.

And then Right. You have a napkin there. So this is a needless complication, right? What we just saw in the video, right? That's also a needless complication. But that is what is called as a Rupert Goldberg machine. This guy, right, he made a lot of, you go to YouTube, right, back in the 60s and 50s and 60s, right?

This fellow built a lot of these. It's a pointless thing. If you actually see, he's not adding any value. But it looks nice. For an ad, it looks beautiful. So, this is what is called as a, it is a feedback loop, right. There is a feedback loop, but [01:58:00] there is no value. It is a needless complication, ok. But here, right, this lady is here, right.

She is rested here. Now, the intention was, right, they wanted people to actually go and use this, right. They wanted people to go outdoors. So, what they did? They may have made this furniture, right, with, right, with solar, solar power, right. Rather, let me define it like this. They wanted people outside somehow.

So what? So what? What would you typically need, sir? I need wifi. Okay. I need to charge my phone. Okay. And I need light if it's too strong, so I don't like it. Right. I need fresh air. Okay. So if they did all the survey and then somebody said, let us build the furniture like a sunflower, it'll crack the sun.

Okay. So, this thing will self rotate and it will align itself with the sun, taking power from the panel and it will generate some, right, when somebody rests initially, right, when you compress the PSO, it will generate electric charge, [01:59:00] right, initially that will be used to power the device and whatever power you get from the panel, you can use it to charge your mobile phone or your laptop, right.

If I asked you, right, go build something that will pull people outside, would you come with, come up with this? No, possibly no, probably I would not have, right. But how can we get here? How did these people got to here? That is the question you have to ask. Right, once again it is obvious, right? I have shown you the solution.

The point is, right, the whole point of like last seven classes is this one particular picture. If you are linked to the, if you like, if you are focused on the solution space, you cannot solve any problem. This is the fundamental tenet, right? I, how many tools can you learn, man? Everything, sir. There was a, one of my student, right, final year Every single software you, you told me I will not, now what?

It's like there is, if you say C, right? Probably I know 1% or half a percent off, right? [02:00:00] I'm a legacy user, right? I'm using it like 25. 25 plus years, right? If I know 0.5% as a student, how much you, you could have, you could possibly, even if you did not even sleep, right? That's the limit to what you can do.

Then what is the central question, right? What is the central question, right? There is a biologist, right? What is this? This we live in an age of abundance. Abundance of information. Ok, the proper slide next class I will show you. He says, we live in an age of abundant information. Information is so much, you are bombarded with more than all of human knowledge.

What does Jimmy Wells say, the co founder of Wikipedia? My goal, right, if you go, right, this is what he says in his biography. He says, is to collect all of human knowledge and give it for free. That was his intention, right, when he started Wikipedia. In that sense, it has happened. See, I used to buy, how many of you, right, guys, listen, right, I come from a time, I am saying 2000, 2003, where I have bought DVDs for 2000 rupees with an encyclopedia.[02:01:00]

Would you believe that? I still have old Britannica DVDs, 5 volumes, for 2000, 3000, I look for a bargain. Howstuffworks, have you visited that website, howstuffworks. com? I have the original CD of that website, of that website, later on it became a website. I have the complete, right, and it is obsolete knowledge.

I paid 2, 000 rupees for it like 20 years back. Right. So that, that was the norm back then. If you needed knowledge, you have to pay. Today it is free. Everything is free. Best. You get educated by the best in the world. You go to YouTube, go to Coursera Index, everything is free. Right. But what is the problem?

The problem is, information is there. You have to connect the dots. I, with this, what can I do? This information, what can I do? Right. What can I produce of value? Right. Right. Right. That again, give it to somebody, right? So that's the key question you should ask. So the question you should ask is, in 10 years what will happen?

Right. Note down, I might have told this earlier, right? Just in case, right after the risk of [02:02:00] repeating WEF, world Economic Forum. Have I said this before, right? Job reports? Did you check it out? 2023? No. Right. That one page summary is there. I think I put it in the slide also. Right? That please follow that.

And it is not. Comprehensive. It gives you an idea. They are also human beings, right? It is done by some of the best, but not necessarily, right? So, what you want is, right, the biology says, you need to connect this information, process it. The future belongs to those who can take that information, process it and add value.

Right? That's the key thing. So, If you have to do this, right, if I say, the objective is to pull people outside, then you have to ask, okay, what would draw people outside, okay, whatever I have inside, I will give you outside. On top of that, I will add some value. Not everybody, even with this, not everybody is going to go out.

But can I pull some of them outside? That is the objective. Got it? Right? So, understand the whole thing. Right. Can anyone summarize today's thing for me? That's it. I am done with the [02:03:00] presentation.

Right. I am done with the presentation. Can anyone? Right. I will explain today's assignment. Right. Then we will part. I will let you go earlier. Right. I cannot stand here. Can somebody summarize it for me? I will give you a mark. Anyone? Any volunteer? Guys, please. Go on. So, what did we learn? We learned any complex system that has to adapt, right, has to have complexity, good complexity.

For a system to have good complexity, it needs to have a lot of internal elements that are connected to each other which constitutes multiple feedback loops which talk to each other. And we said, [02:04:00] a system, right, if it has to survive it has to have a, it has to have a? Purpose. Purpose, right. A system has to, a system needs to have a?

Total purpose. All of you. Purpose. Purpose, right. A system has to have a purpose, right, otherwise there is no point in, right, the existence of a system. What is purpose? What is the formal definition of purpose? All directed behavior. right. Now if that is absent, there is no need for a system to exist. Now this system has got a boundary and it has to constantly interact with the, with an environment for its survival, right.

So when it does so, there is an external stimulus on the system which actually upsets the system. We call this difference, right. There is a system, there is a external, what is the external thing? In this case, room is hot, right. Now my body is getting hot. It was at 98. 4, now it has become 100. What does my body do?

It responds. It responds by what? By doing whatever it can such that it will bring it down to where [02:05:00] I can actually stay comfortable, 98. 4. It will try. It is trying, but it will try. It will keep doing that. Do you understand? That is why when you turn on air conditioning, your body has not, need not struggle so hard.

Why don't you sweat in an AC room? Because there is no need for you to still sweat in an AC room. You are doing an external stimulus. You are doing an external stimulus. That is why sometimes it is bad, why? They used to do this badly, they are saying, right? This has to, this, now, if I am sweating, internally the whole system is working.

If I do not do that, what happens? Right? The internal loop is disturbed. It is not being used. That is why if you do not sweat, it is a bad thing, they say. Yes or no? Right? People who sweat, right, generally, kidney disease if you take, will come to those people, generally, right? People who do not sweat at all.

If you don't work out, if you don't sweat, your kidney, why? All the urea, all the thing that your body is excreting through skin. Your skin is the largest organ in your body. That is excreting a lot of waste. So it is taking some work from your kidney. And it is [02:06:00] doing the, right, in the process of cooling, it is also getting a excretion.

It is removing a lot of bad content from your body. So if you are sweating a lot, if you work out, the workload on your kidney is reduced. Got it? Since that is reduced, your kidney will work longer, better. Right? If you don't do that, if you don't sweat, if you sit, if there is no mobility, what happens? Your kidney has to do more work, depending on how good your kidney is, right?

You may be fine eventually, right? That lead to problem. Understood, right? So this stuff, think about feedback. Now there are multiple feedback loop. We said there are positive, negative, positive feedback. We said mostly it's not preferred, but in certain occasions, right? I gave you the cell phone cover example, man.

If you have to disturb the equilibrium consciously, it may swap between a positive and a negative feedback group and it'll always maintain a set point with a negative feedback group, right? So the loop we saw, then we saw delays, how can delay actually destabilize the system, right? It can cause problems, right?

And how do you actually deal with it? I [02:07:00] gave you example of COVID, then I gave you example of network theory, right? How we saw, right? How it can cause problem in online meets, how it can cause problems in financial transactions, right? Just to wrap up. And finally, what did we say? Right? Using these principles, right?

Using the, this loop, right? These new product development principles, right? engineer, what is a product? Right? It's a service, right? Or it's a product service system for you guys, right? It could be in the form of an app, or a backend, platform, anything. Right? So, if you have to do that, mostly you will be put under deployment.

Right? Guys, listen. If you do not know, I will quickly let you go, right. So most of them you will be put in deployment. Just because you are put in deployment does not mean you cannot innovate, right. You will understand many things. It will change your perspective. You can go back to discovery, right. Then you can operate in that space.

Understood? Then finally we saw how do these feedback loops, right, right, cause their interdependency, right. What is interdependency? The example of coal we saw, right. Just in the process of exploring coal, they found water which [02:08:00] is actually useful for driver steam engine. This is a good thing. Right. How one thing led to another.

This creates a dependency in a good way. Right. That example we saw. Then we also saw finally, right, about some feedback loops just for entertainment. Why do we use this? Like a Rupert Goldberg machine. And the other important thing, the tracking, sun, sun tracking chair. Right. Where the intention is to get somebody out.

Right. How do you build a solution that will fulfill that? Right. Any questions I'll answer. Otherwise I'll explain today's lecture and I'll let you go. Right. Guys listen. So hopefully, right, maybe two more days, I'll give you extension and go back and push the data a little bit further, right? So identify the feedback loops in the model.

Take your model, understand this different feedback loops, right? Which means you should have done snack analysis, right? Without that, you cannot do this, right? You should have completed it until up until groups list. Those groups that keep the systems stable. Riches negative feedback. What are the negative feedback groups, right?

I showed you the example of Covid, right? [02:09:00] Similarly, for your system, you tell me. List down those loops that have a potential to destabilize the system or change the system, right? Positive, positive feedback. And identify critical intervention points. What are critical intervention points? If I touch this, it will collapse the whole system, right?

So, this will be the assignment for this week, right? Maybe I will push this deadline, maybe another week from now, right? Any questions? There are no questions, right? We will wrap up. Anyone who wants me to, yes? I have to read using a translator. It's the same. Louder louder louder. How do you read it? How do you read it?

Uh, how do you read it? Uh, I read. How the vessels stop? How? How do you open it? How? How is it? How do you read it?

I think it doesn't look really good. Oh. I think it doesn't look [02:10:00] good. Okay. They're both tough, right? So I'm, what's your name? Both are tough. So Abish is asking a question. So his question is, sir, you are still losing the word, system, system. I don't have a system. You gave me a, asked me to identify a problem statement.

Right? Where is the system in that? Correct? That's the question. Right? Some level of abstraction is required, right, in this case, I will take this example, right. So, this thing, guys listen, guys listen. So, in this case, let me explain this problem statement. This problem statement is, I have lot of old hardware, old computers, right.

Yes or no, Abhishek, Abish, right. So, lot of these old computers are there, right. No. It's an e waste, right? After a while, it may be working also. Most of the times, your [02:11:00] phone when you throw away, right? Most of the times, it may be working actually, right? Just that it's obsolete, right? Maybe it's running an old operating system.

Or their display is not good enough, camera is not good enough, you let them throw it. Now, his problem statement is, his team, what they are saying is, Sir, can we use this for something else? So, Abish, what I would do is, that is why I say, if you jump to the problem statement, this will be the problem. Take a step back.

Look at that domain. What is that domain? Waste management actually. If you look at a broad level, this domain is, waste management or waste reduction, right? Not even management. Now specifically guys, listen. This is a case study for you guys man, it will be helpful for you guys also. How should you think is what I am, how should you approach is what I am covering here.

So in this case, he started saying, sir, lot of waste, we are ending up throwing, what to do? And you are talking system, system, what is this? Right? I will, I will answer that. Talk about, right, e waste reduction. Correct? Abish? [02:12:00] Now, that e waste is where? It has to be part of a system, right? Right. Right. Who is creating the system?

Consumers. So, there is a system. Right. You can take, you are free to define. That system you can take entire India, entire South India, Chennai or college, that you are free to do. So, I say, in a given geographical location, you Right? Very rare. This many computers, this many calculators, this many laptops, this many blah blah blah, people are throwing it away.

And, what I am looking at this, can it take this and do something about it? That's the question I have to ask. This is your whole system. Now that is broadening your perspective. If you zoom in to, say, say I am going to take a phone, now I am going to, Repurpose it. You, it'll be proud of it, right? If you take a step back and ask that question, let me look at the whole pattern now.

Why am I asking you to do this? Right, guys? Listen, guys, listen. [02:13:00] I, I'll get back, right? I'll add more value. Actually, you are making your life easier by asking this question. I wish someone else would've done this, right? Google had a beautiful idea. Are you aware of the project called Google Docs? Right? Some of you may be aware, right?

Raise your hands. Anyone, how many of you're aware of this project? Right, all the way man. This way, I don't know. This way. Right? You are aware of it? Right? What was Google's idea? It was a beautiful idea, but why did it not take shape, Babish? Badri, why? I don't know. I don't know. I'll tell you. I'll explain.

Okay? Let me explain. Why do you change your phone? How often do you change your phone, man? Five years. Okay, how often do you change your phone? Four to five years. right? How often do you change your phone, man? Last game. Blue shirt. Yes. Just show a finger, 3, 5, 2. Last guy. Every 4 years. Right? Let's take an average of 3 to 4 years.

Guys, listen. [02:14:00] Guys, listen. I'm actually answering Abish's Right? Now, every 3 to 4 years, I am changing my phone. Why am I changing my phone? Because the camera has gotten bad, sir. For me, right? If the battery goes bad, I can always go and get a, get it fixed, not a problem. But, one of the main reasons why I keep changing my phone is every three to four years, right?

Camera quality becomes so compelling, right? I photograph a lot of intricate mechanisms, right? If you take my phone, right, it will be full of, right? Or anything I find interesting, I photograph. So, which means, image quality really matters for me. I, what interests for me is macro photography. So, if you give me a phone with excellent macro, macro photography, I'm interested.

Okay? That is me. Somebody may value a good display. Somebody may value, a gamer might value processing power, right? So what Google asked is, okay, you have a phone, let us take the Lego approach, okay? This will be the battery. [02:15:00] This will be the camera module. This will be the silicon, systems on a chip. This will be other subsystems.

So when something goes out of That goes bad. Or if it becomes too old, remove the block. Know the camera. Take that swap with the latest camera. What a beautiful idea. . Are you getting it? Yeah. Right. So what Google taught us, I have, I have a template basic, just a display with a few slots. I will take every module and as asset I need, I don't have to throw the whole phone.

Aish. I will take that module and replace it. How did they get to this idea? Right? So they are asking the question. Right? I don't want to throw the phone. Okay. Then they ask the question. Right? At a systemic level, why are people throwing their phones away? Battery goes bad. Operating system is obsolete.

Okay. Software I can upgrade. Software I cannot upgrade, sir, because the microprocessor doesn't support. Okay. Let me change that thing alone. [02:16:00] Because for me, right, for my father or my mother, right, age quality, as long as they take a picture, they are happy. Right. If they have a decent screen, they are happy.

Ten years also, my, my grandmother will be fine. Right. Processing power does not matter for her. But for her, if the operating system keeps updating, right, if there is no support, just change that module all over. How to understand? You understand? Someone like me, I value camera. So, that module all over, I will keep replacing every two to three years.

And for all of us, battery will go bad, right, every two to three years. So, you change that. Right. Got it? Amazing. So, this was Google's idea. But why did it not, they pushed this idea really hard. The problem is, right, this idea would mean your one trillion dollar Apple relies on what? Selling new phones. That business model will not sustain.

It is not, from a business standpoint, it is not an economically feasible idea. Most companies did not support this. Samsung, Apple, they did everything. They did lot of lobbying to stop, to kill this idea. So this idea was dropped. [02:17:00] There are technical problems, ok. I am not saying, right. For instance, if you drop your phone, it will, it will go into ten pieces, right.

And how do you connect these? Right. These things have to talk to each other, right. Connections will corrode. How do you make it waterproof? There are, there are challenges, but it can be solved, right. So, this idea may come back, right. You understand, right. Now, uh, right. Repair yourself movement, right. Self repair movement is how U.

S. is gaining traction. Lewis Rossman, are you following that, ok. There is a guy on YouTube called Louis Rossman. He is actually, he is a independent repair guy with no big education. He is actually fighting in US to bring back, right, saying Apple has to provide parts that you should be able to repair it yourself, right.

He is undergoing for that idea, right. You got this ambition. Now you understand at a systemic level, right. How do you get to this? If you have to go to this, you have to ask the question, why are people throwing their phone away because of so and so, who are the stakeholders, what are their needs? Now, that is a crucial intervention [02:18:00] point.

I say, right, you write the objective. This is what happens. People throw their phone away because, or to satisfy a certain, right, to enable a particular customer like me to take a photograph within what is an alterable, what would be an alterable for me. Maybe I am willing to change the, the bar with the thickness of the phone.

I will be, I will be fine. If it is too heavy, I do not care, What is the constraint? Price is a constraint for me. I am not willing to pay about 20, 000 rupees. Write down. That is one objective. If you do that, then you take a step back and ask the question, Okay, this guy needs this, this guy needs this, that guy needs that.

How can I build one thing that will fulfill everybody? Then let us modernize the phone. Man, I can customize it to each and every requirement. Similarly, Amazon packaging, have you seen? Right? So, right, these days what is happening? Earlier, they used to put big box. Now they have multiple folds in the box, especially if you buy books.

Some book will be this [02:19:00] big, some will be this small, correct? So they actually have creases, right, and strategic points where they can actually fold and it will exactly come to the size of the book, right, that is modularization, not the idea of issue, right. So that is how you attack a problem, right. Any other, any other team wants to discuss their idea quickly, right, I actually gave them an idea.

Do not use the rubbish, right, just to give you an idea, this point is. Any other team? Hands going up in the beginning. You want your idea discussed here, tell me, let us discuss. Right? So, right. It'll give you more clarity. Right. I'll let you go another five, 10 minutes. No. See if you let me do, right. If you tell me Right.

It'll benefit you and it'll benefit every other team. Also, this is helpful, right? Some practical cases like this. Right? So one more tip. Tell me, you guys raised your hands, right? No. At the beginning I said who has struggled with the problem state, but tell me your problem. Yeah. Yeah, [02:20:00] yeah. Let's see if we can just give you some direction.

Something to do with farming instead. That's all I remember. And then you change something else. What is that? It's

already implemented. Now the question is, okay, let it be already implemented. That's okay. Or do you see any gaps in that, any, anything that we proved there? Actually, we do not. I mean, our thing also, our thing is gaps that we have to fill. It should be necessarily, what is called, demand interval. Interval already implemented.

You want to throw some more light on your ID specific queries? Please, he asked a very clear question. Sir, I am having one phone and you are talking about a system. Right? Now, I am able to make him understand. Like that, do you have any confusion? You have trouble concentrating on this very matter. [02:21:00] If you tell me, then I will actually take a step back and help you.

See, understand one thing, what should you do?

So, what you should understand is, right? If you do this, right, you will just keep hopping. I can, see, it's been seven, seven classes. I'm not blaming you, right? You are at an age where you'd like, once you hit a roadblock, you'd be like, I'm not able to see it. Try to ask him, ask him if there was 3, 4, 5, 6.

Sanjari. Then? Just like that. What are they telling you? Just like that. All the complaints, right, correct, I call it from memory. All the complaints, we will put down on a register. Right, which is actually a bad thing. There is no additional documentation. And by the time it gets addressed, [02:22:00] it is too late.

Right, and there are multiple problems and each have their own reporting mechanism. And there is no one single integration. Right, there is no one single integration. Now, we want to do something about it, correct. That is the broad thing. Now, the question is, right. Don't start here, right? Start with the problem.

What is the problem sir? We go to the complaint register, we write, and it takes two days to, for us to resolve one problem. Okay? Write now problem resolution time long. I want to cut that one, right? We, we'll see what, how next. This is one problem. Second thing, I have to physically go to the register and write down.

I'll be happy if I can do it from my room. What is the second thing? Convenience. Second thing. Okay? Stakeholder, what are the needs? One need is quick problem resolution. What is the second thing? Convenience. Right? Third thing. Who is the other stakeholder in this problem? [02:23:00] Probably the electrical guy. The guy, uh, whatever, right?

Different, different things, right? Bathroom, you have washing machine, right? Different stakeholders have. What are their needs? Start documenting. Write down the end of needs. And what is the constraint they have? Sir, they have four people, say three people. If you go to a state, right? When I call, right? When if I ask our admin guys, they'll be like, sir, we are warworth.

We can hardly add to any problem. So what I will say is right if the washing machine is going bad, right? Why? If there is a frequent, if there's a frequent failure of a why, okay? Which means. Now you come and tell me, sir we checked there is an online portal, you just go, give, done. Right? Now this is where there is, right?

Let me see if I can make it better. So I am going to ask a few questions. Guys listen, right? Take a problem statement, write a problem statement and see if you can do anything better. So what are the problems? Let us focus on the problem. One is, right? [02:24:00] Washing machine repair, right? Maybe your fan often breaks down.

Your light often breaks down, right? So on and so forth. Right? At least the way I see it. All the inventory. Right. I am part of the hostile management. As far as I know. We have a very poor documentation. When I say poor documentation, it's all paper. Some note it's written there, right? When was this bulb changed?

There is no record. What is the average use usage of that lifespan, of that bulb? Nobody knows. If you go ask the guy in the estate, right, he will have some heuristics. What is heuristics? Every asset, 10 bulbs will go, I will buy and give them. That is all he can tell you. Can he say. Today I changed this bulb and the average utilization rate is, let's say, 10 hours per day.

I expect it to fail on January 2026. Can you say that? Would you be able to help them? Got it? This washing machine I repair, average usage is 100 hours. Right? Every service needs, between every, 500 hours, not 100 hours. Whatever is the time, you find out. Right? [02:25:00] 500 hours. Today servicing is done. Can I make an entry and do a preventive maintenance?

I don't wait for it to fail. Can I repair it even before it fails? Or can I give a advance notification to the manager and say, My car will tell me, serviced you 500 kilometers before service. I'll give a warning before 2, 500. 100 kilometers, it will not start. It will trouble me twice or thrice. Then it will start.

You understand? Now you see, now the very problem you saw, I am not able to proceed further. Right? How is it I am able to give you instantly? I didn't think about it. Right? How is it I am able to think about it is just that, just that, first thing is attitude. What is the attitude? I can do something about it.

Guys, this is very important. First thing is I believe. This is why I said, I should believe first, you can do something, you believe, I can improve it. First is conviction, no proof. Just believe you can do it, first thing. Second thing, belief alone will not heal you, right, you have to be pragmatic. Now the question is, take a step back and ask, why do [02:26:00] things fail, right?

Yeah, things fail, they will fail. There is something called MDPF, mean time between failure. Okay, your hard disk is a very important parameter, right. Hard disk says, I 20, 000 hours, the hard disk will die. So I have a preventive maintenance schedule, ok. Once I, my hard disk failed. All the data, I am talking 2004, ok.

I had a 160 GB hard disk, my grandmother's photo. She is no longer alive. Her photo was there. I had no backup. I had a backup on a CD. The aluminium foil right on top of the CD is gone. I am not able to read the CD. All the memories is gone, right. How much ever I paid, took it to get a data recovery. They could not recover.

Gone. Gone. Gone. So then I started studying, right? Then I came to know there is actually a,

there is actually a pattern, right? If you buy a hard disk, right? Failure rate, right? The failure chance versus time. [02:27:00] Initially, right, for the first 100 hours, 200 hours, high chance of hard disk failure. This is how it follows a path down curve, right? Initially the chance of failure is very high, right? And if you cross 200, 300 hours, and if you don't abuse it, it will work fine for 5 years.

Right? Then exponentially the failure chances goes up. So what I do is, I don't wait for my hard disk to fail. I look at a, if you go and check the hard disk, it has got a countdown timer. It records how long it's been running. It says power on hours. If it crosses 20, 000 hours, I don't say, I simply replace it with a new one.

You understand? So similarly, Right, we cannot throw away bulbs, still, right, now can we have a prediction, saying, we are able to use statistics, data analytics, all that comes in, as a CS engineer it's a beautiful thing, which means now the question is, you go find what sort of, for LED, or for, right, CFL, this is the trend, right, this is for a lattice, for [02:28:00] a CFL if you see, for this LED you see, there will be a trend like this, lot of data, how many bulbs are there.

Create a database where you have a nice, uh, right now it's all just clicking. Can you, but can you, what is the constraint? We use a, we use a PHP server. Extremely outdated technology, but that's what we use. In that, right? Or, can you build something, post it on our website? Within this, that can be updated. Do you understand?

And when I go click for the maintenance guy, you give a complaint, it blinks. Yes. Yes. Yes. This guy has a problem. He doesn't have to go and look for it. Right? Then I, I give a prediction. What is prediction? Okay. Next one week, these pumps are all about to expire. You go check. Water filter here, last time they changed the filter, this time they have to go check.

You understand? So a lot of improvement is possible. In terms of documentation, creating data, predictive analysis, failure analysis, failure prediction, [02:29:00] so much you guys can do. Now can you guys work on it? Right. So any other problem statement, guys? Write two problem statements. We saw anything else? If you tell me, I will actually give you a solution.

I gave a solution to both of them. Anything else? And I did not think about it, right? Guys, any, any, anyone? Some of you raised your hands. I saw your hands go up here. At least four people here. Four people. No? Everybody is fine? Then I will wrap up. If you want to discuss, you can come now. You want to discuss?

Anybody wants to discuss? Okay. Fine. Then we'll call it today. Let see you next week.

Wanna go to the cafeteria? We drink coffee. I am. Go to cafeteria and then you go sleep.

You and I have when? Nine to 10? No, [02:30:00] no, I have those. Band also.

I did not, that's the thing. Man does not, man does not know how to say no.