

The basics

Class discussion

[Students enter the class slowly, not looking at the professor. They slowly settle down and eventually become silent as the professor begins to speak.]

RADU: I noticed a couple of you have coffee. Can one of you talk about how that coffee came to be in your hand this morning?

MING: What do you mean? I just bought it and came to class. Not much to say.

RADU: So you admit to experiencing operations management in action this morning?

MING: Ummm, I just bought coffee and brought it here, I am not sure I admitted to anything.

RADU: But is getting coffee to class really that simple? How would you describe the process of how you bought coffee?

[Ming hesitates, looks around for others to join her in rolling their eyes.]

BINESI: Okay, I'll try. I asked the person working at the coffee shop for coffee, I paid, and then got my coffee. Then I left to come here.

RADU: Very good. That sounds like a perfectly sensible process for getting coffee. Who would like to draw it?

[Students hesitate as Radu waits with a piece of chalk in his hand, offering it to the students.]

MING: What do you mean "draw it"?

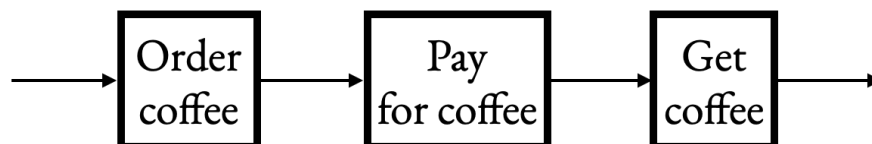
RADU: That's my question. How would you draw it?

[Students look at each other and no one raise their hand. Then they look at Radu and start to think. For a minute, both Radu and students do no say anything.]

FARAH: I'm not sure if we are talking about the same thing, but I think I have seen things like this before in an engineering class. You draw boxes and arrows to represent the logic of the steps in the process.

RADU: Please show us. *[Hands Farah some chalk.]*

FARAH: Well, it would look something like ...*[Draws the following figure without speaking.]*



RADU: Does this make sense to everyone?

CAMILA: Hmm ...I am not sure how this is much different than what was said in words. It's just that we replaced commas with arrows and put the phrases in boxes. I mean, it looks nice, but not sure how this is helpful.

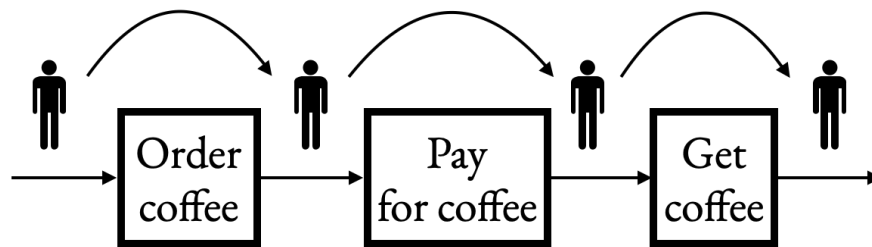
RADU: [To Farah.] How would you respond to Camila? What motivated you to put them in boxes and arrows?

FARAH: Honestly, I just remember doing this before. Maybe it is easier to read?

RADU: True, true. Anyone else find this picture useful?

BINESI: The arrows suggest to me like movement. Like things are flowing from one step to another. I can almost see myself walking from step to step.

RADU: [Grabbing more chalk.] Something like this? [Draws on the board.]

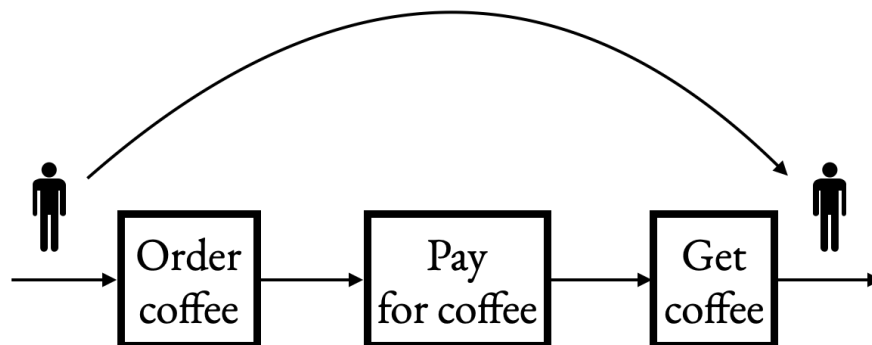


BINESI: Yes, exactly.

RADU: We call this a process flow diagram. Things flow into, through, and out of the process. What flows in is transformed through different steps along the way. We call these steps *activities*.

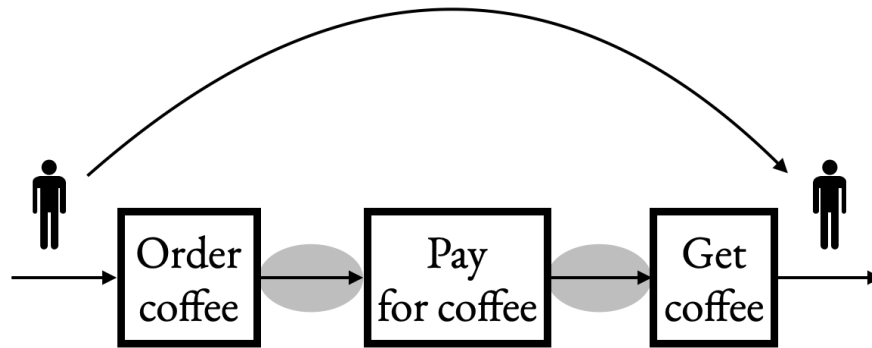
CAMILA: But wait a minute. In the picture, it looks like the customer is moving. But, as far as I have experienced, when you buy a coffee, you pay, then wait there, then they give you your coffee, and then you leave. You are not moving around that much.

RADU: Ah, I see, so you feel it looks more like this? [Radu adjusts the figure.]



CAMILA: Yeah ...

RADU: [To Binesi.] Binesi, when you said you could “see yourself moving from step to step”, did you think of yourself physically moving from step to step? If not, what is moving along these intermediate arrows? [Points to the highlighted arrows.]

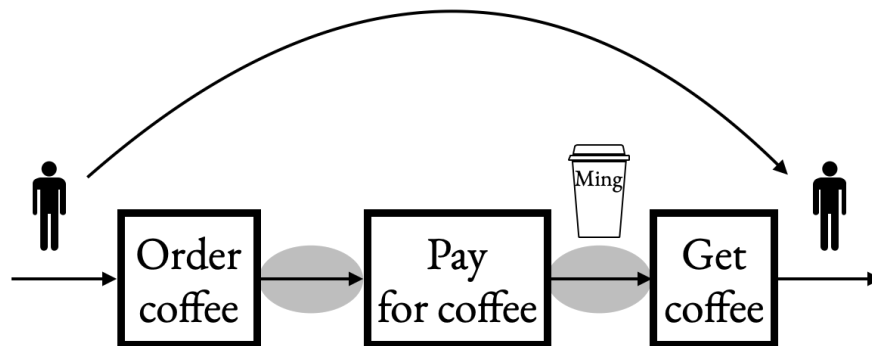


BINESI: You know I didn't think about what Camila brought up. I guess something like a "proxy" for me is moving along those arrows. Like when I order the coffee, the worker takes a cup of coffee. That cup kind of represents me; she puts my name on it.

RADU: Precisely, this is what we mean by things being "transformed" along the way in a process flow diagram. Can we draw this "cup with my name on it" somewhere in the picture?

BENESI: It should be above the second highlighted arrow.

RADU: Like this? *[Drawing on the figure.]*



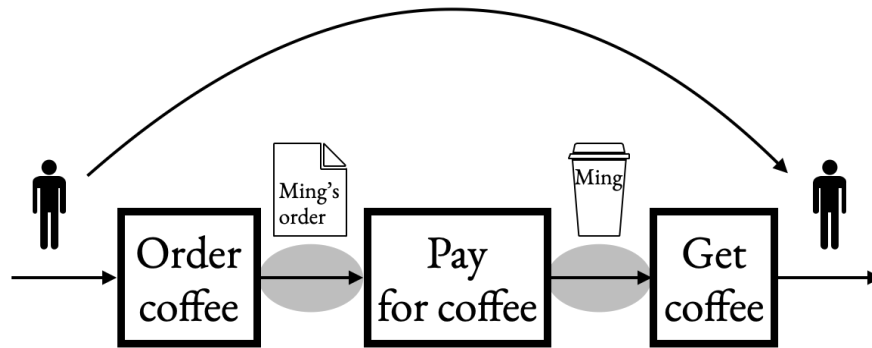
[To Ming.] Ming, I hope you don't mind. I put your name on the cup.

MING: Sure, what the heck. But seriously, now I am confused about what we could draw over the first arrow.

RADU: Any guesses?

HAOYU: Isn't that kind of like the "order" of the customer? It is represented in the computer or whatever.

RADU: Ah yes. Like this? *[Draws on the figure.]*

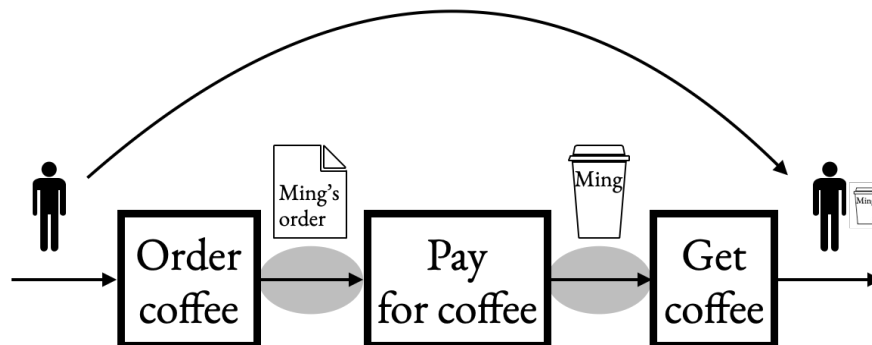


HAOYU: Right, looks right.

RADU: Very good, I feel we are all liking this. Can we give some names to a couple of things? These are names that are common when drawing process flow diagrams. If I had to call one of the little pictures we drew above an arrow the “input” to the system, what would you choose?

FARAH: [*Excitedly.*] This is coming back to me. We would call the customer coming in the “input” since this is what initiates the sequence of events. And by the same logic, the customer coming out of the end is the “output”.

RADU: Very nice, this is exactly right. But do you mind if I change the picture a little bit to help clarify this? [*Adds a cup to the hand of the customer.*]



RADU: Why would I do this, Farah?

FARAH: Ah yes, of course, because the customer that is the input has been “changed” to the output. She now has a coffee in her hand.

RADU: Precisely, the input is a customer, and the output is a customer with coffee. Very nice. Are there other things we might call inputs or outputs?

[*The class pauses to ponder.*]

MING: What about the coffee itself? How would you classify that? It seems both an input and an output.

RADU: Why do you say that?

MING: Well, the coffee is poured into the cup at some point, which makes it look like an input. But the coffee is in the cup when the customer leaves, so in this sense it looks like an output.

FARAH: But Ming, you answered your own question. The coffee in the coffee pot before being poured is an input, and the coffee in the cup, in the hand of the customer, is an output. It has been transformed.

MING: Hmm ...I see. But then, what about the person who makes the coffee? How could you classify them? Are they an input or an output?

RADU: Another good question. What do you think?

MING: I see, this is how it's going to go: if I ask a question, it gets sent back to me ...*[The rest of the class laughed.]* I am learning. Well, to answer your question ...or I guess, my question ...I feel that inputs and outputs don't quite fit. That is why I asked.

RADU: And why doesn't the server fit either the input or the output?

MING: Well, for one, the customer comes and goes, and the coffee comes and goes, but the worker just stays there. So I am thinking they are neither an input nor an output.

RADU: Precisely. They are something else. The worker is something we call a resource. Does anyone want to venture a definition of resource? What characterizes something we ought to call a resource?

CAMILA: I'm sorry, I'm a little lost. Why can't we just call the worker the worker? Why does it need another name? I find all of this a little confusing.

RADU: You are confused about how to get coffee and bring it to class?

CAMILA: No! I have one right here. I am confused why we need to give things these names, or whatever we are doing now.

RADU: We are learning operations, of course. This is not about coffee, but we are using the example of coffee to learn about some general principles and concepts of operations management.

CAMILA: Then why don't you just tell us the concepts and what they mean?

RADU: Well, I feel I don't need to tell you. I think you already know. Why would I explain something to you that you already understand? Camila, tell us, how would you define what a resource is? Maybe in terms of its relationships to inputs and outputs?

CAMILA: *[Pauses.]* Well, I know the worker takes the order and makes coffee out of it. And the order is the input, and coffee in the cup is the output. So maybe the general definition of a resource is something that converts inputs to outputs.

RADU: Excellent! Camila, did I need to explain it to you?

CAMILA: Apparently not.

RADU: Haoyu, tell us. Is there another resource in the coffee story?

HAOYU: I wouldn't know; I only ever order tea. *[Everyone laughs.]*

RADU: *[Laughing.]* So, is there another resource involved in the ordering of tea?

HAOYU: I cannot think of one.

RADU: Anyone want to help Haoyu here?

[Students are thinking, no one ventures an answer]

RADU: Okay, so let me get this straight. You go to the coffee place, you ask for coffee, and then you leave. You and your request, along with the coffee brewing in the machine, are the inputs; the cup of coffee in the hand of the customer is the output, and the worker is the resource that converts inputs to outputs. That's it?

BINESI: No, this is not what I said earlier. You also have to pay for the coffee.

RADU: Ah very good. And so?

FARAH: Well, technically, the request for coffee combines with the money to initiate an order for coffee, so money is another input.

RADU: Very good! But does that mean there is another resource also?

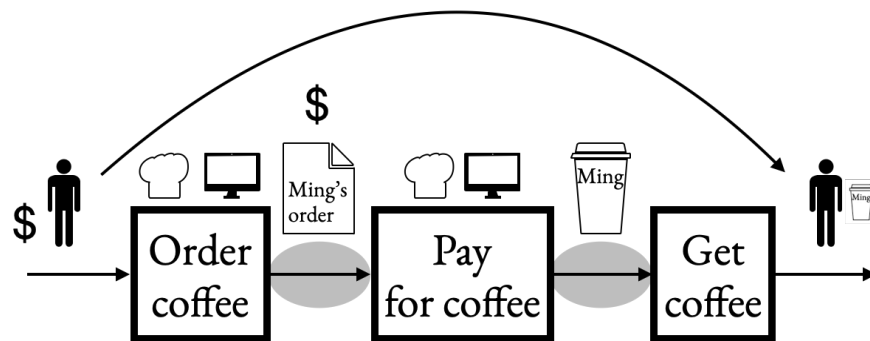
FARAH: Ah, I see. The computer system is another resource. It converts the verbal request and the money into an order on that computer system they have. The worker makes the coffee and then clicks on the computer system to indicate that the order is complete. So the computer system is another resource.

RADU: Yes, yes, very good, very good.

[Everyone seems happy with what they achieved.]

RADU: *[Offering chalk.]* Who wants to draw the resources in our picture?

BINESI: I'll try. *[Grabbing the chalk.]*



RADU: Very good! But I still feel something is missing, don't you? Haoyu, you worked at a restaurant. Are you happy with this picture?

HAOYU: I didn't draw pictures when I worked at my restaurant, so I would say it looks good to me.

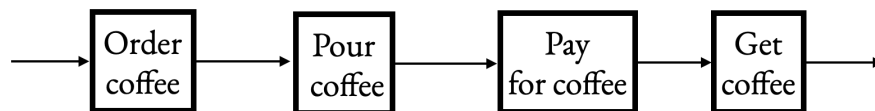
RADU: But you did something at the restaurant, didn't you?

HAOYU: Yes, I made food. Is that what you are after?

RADU: Well, think about it from that perspective, as someone working at the store. Isn't there a step missing in this process?

HAOYU: Well, I guess we didn't have the step of the worker making that coffee and pouring the coffee into the cup?

RADU: Excellent, so you feel the overall flow should look something like this?



[Haoyu nods.]

RADU: [To Binesi.] Binesi, why didn't you include this step in your original description of the process?

BINESI: I guess I felt it was implied by the fact that I paid for it. I was thinking about the step *I* took to get my coffee, less so what the workers had to do. Was that wrong?

RADU: First of all, there is very little that can be wrong in all of this. The thing to consider is what questions we are answering, and whether our answers fit the question. I think it is reasonable to have excluded the step of the worker pouring the coffee when we were thinking purely about what Binesi needed to do to get her coffee to class.

MING: Ah, but the point here is that it does matter about the "pour coffee" step even if we only care about Binesi.

RADU: And why is that?

MING: Because Binesi needs to wait for her coffee to be poured. It factors into how long it takes for Binesi to get her coffee and how early she needs to arrive at the coffee place before she plans to arrive in class.

RADU: Excellent, Ming, you are right. There are many more things to consider here. Let's return to this example in a later class; time is up for today. I will be sending you an email to clarify a few things after class. Watch out for this, please!

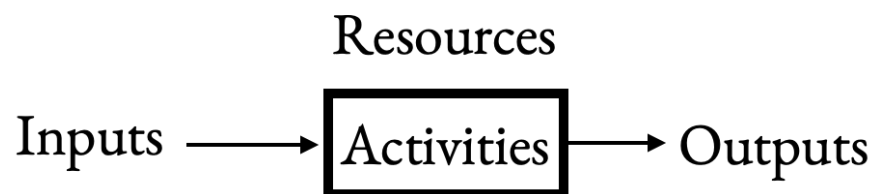
Email

Dear students, great to discuss today!

Some of you talked to me after class, asking what exactly this class is about: What is operations? I will not answer that for two reasons. I think it is better if we find out as we go. Second, I am not sure I have a very good answer. For now, you can ask AI for answers, and that should suffice.

What we worked on today was a basic orientation we use to think about operations: to view them as processes that have flow. The idea of flow evokes water flowing through pipes from a far-away location to where it will be used. Operations are typically physical systems, so analogies to physical systems in nature are useful.

In the course, a flow will consist of four components that we visualize in the following figure:



Let me briefly describe the components.

- **Inputs (I):** This is the stuff that flows into the system that initiates "work." Think of components in an assembly line or customers arriving at a restaurant.

- **Outputs (O):** This is the stuff that flows out of the system. Think of assembled goods to be sold, satisfied customers leaving a restaurant, etc.
- **Activities (A):** These are the things that are “done” to turn inputs into outputs. Think of assembling components into goods or serving customers.
- **Resources (R):** These are the people, tools, machines, etc. that undertake the activities that turn inputs into outputs.

The “syntax” of a process flow is like this:

R turn I into O by doing A

Here are two examples of formulations in that syntax:

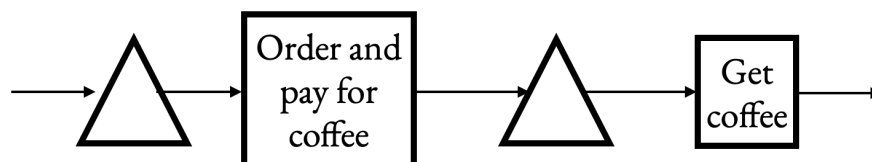
A machine turns components into a good for sale by assembling them.

Servers turn customers who arrive at a restaurant into satisfied customers by serving them.

Of course, in a complex operation, there are many resources, inputs, and activities, and sometimes even multiple outputs. In the cases we read in the weeks ahead, you will see many examples of these, including in the “Extensions” assignment.

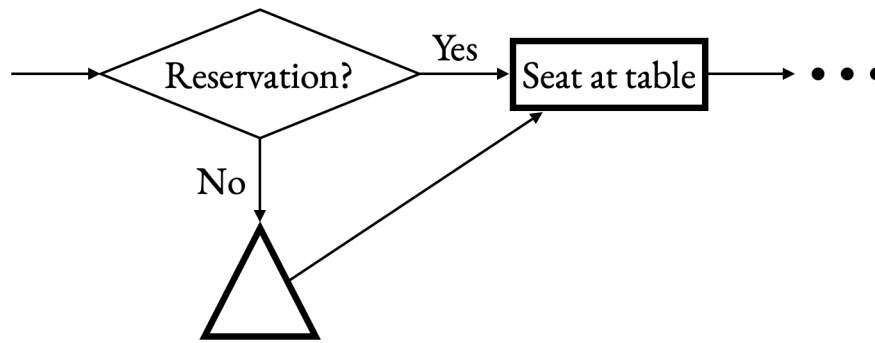
In the next class, we will also be drawing some more process flow diagrams. Two additional symbols may be useful there, and in many other places. In addition to boxes and arrows, we also have triangles and diamonds. Triangles represent a special activity: waiting. You might think that waiting is not an activity at all, since nothing is being transformed; you are just waiting to be transformed. But, in a sense, this is where “time” is changing, and this often matters. The longer you have to wait for coffee, the less you like the coffee at the end (or maybe in some extreme cases, you might actually like it better?)

Here is an example of what the triangle looks like and how you use it:



We are back at the coffee shop again, but we need to wait in line to order. This is represented by the triangle to the left. Unfortunately, after we order, we must wait for our coffee to be made. So, there is a second wait represented by the second triangle. Usually, these two waiting actions take place in different physical locations. The first triangle is a line in front of the cashier. Usually, the second wait is off to the side. I am sure you are familiar with what can happen when these two areas are not well-distinguished. A lot of asking: “Are you in line to buy or have you already ordered?”

The second symbol is a decision point where the flow “splits” into two paths, where potentially different further actions are taken. Let’s stick with the restaurant theme and think of going to a fancy restaurant with a host at the door. You go to the door, and the host says: “Good evening, do you have a reservation?” If you say yes, he checks the computer to verify. Once it’s verified, he takes you to your table; otherwise, he asks you to sit and wait for a table to become available. We could represent this something like:



Let me end this email with a little bit of background. Every idea has a beginning, and those beginnings are not always well-documented. The idea of drawing boxes and arrows to represent a series of steps that happen again and again is probably hard to date. But certainly, the need to document such processes became more acute with the Second Industrial Revolution of the 1800s. This was the beginning of the era of mass production, where documenting repeated steps to produce an output became essential as such steps were repeated and multiplied on larger and larger scales.

The earliest documentation I know of what we might view as a “modern” process flow diagram comes from the paper [1]. The Gilbreths—Frank and Lillian—are a fascinating couple in American history. They were important figures in the early development of what we might call a “professional” managerial class, innovating and promoting many of the ideas we will discuss this semester. The couple famously had thirteen children and raised them with a view towards efficiency—with sometimes comedic outcomes. They might, for example, have drawn flow diagrams for how children ought to get ready for bed. This efficiency approach to child rearing was captured in the book [2], written by two of the children of Frank and Lillian, and later adapted into movies of the same name (in both 1950 and 2003).

That is all for now! Warmest, Radu.

References

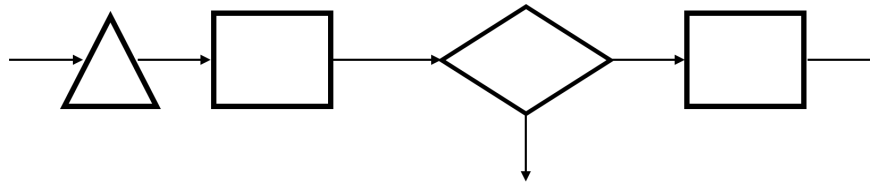
- [1] Frank B Gilbreth and Lillian Moller Gilbreth. Process charts: First steps in finding the one best way to do work. *Transactions of the American Society of Mechanical Engineers*, 43:1029–1043, 1921.
- [2] Frank B. Gilbreth, Jr. and Ernestine Gilbreth Carey. *Cheaper by the Dozen*. Thomas Y. Crowell Company, New York, 1948.

Extensions

[Posted as homework on the course’s website for this class session.]

1. Describe your typical visit to the dentist, using process flow diagrams. Be sure to include inputs, outputs, activities, and resources.

2. Describe a real-life scenario that accurately fits the following process flow diagram:



3. Can something be both an input and a resource? If so, provide an example. If not, argue why not. What about both an activity and a resource?
4. Describe two processes for which you are an input. Describe two processes for which you are a resource.
5. You and a fellow student decide to work together on finishing your homework together in finance class. What activities do you need to divide up? Do they need to be done in any particular order? Draw a simple process flow diagram of the steps, and be sure you include yourself and a fellow student as resources, labeling the appropriate activities.
6. Return to Radu’s “syntax” from the email: R turns I into O by doing A. Write two sentences in this exact form for operations you know well—one from a workplace, one from ordinary life. Then try to break your own rule: describe a process where you find it genuinely hard to say which thing is the resource and which is the input. What made it hard?
7. In class, Ming argued that the “pour coffee” step matters even if we only care about Binesi, because Binesi has to wait for it. Take a process you know and draw it twice: once from the point of view of the *customer* moving through it, and once from the point of view of a *worker* inside it. Which activities appear in one drawing but not the other? What does each drawing make easy to see, and what does each hide?
8. Radu drew *two* waiting triangles at the coffee shop—one to order, one to receive—and noted they usually sit in different physical places, which causes the “are you in line or waiting?” confusion. Recall a place you have been where two different kinds of waiting were badly mixed together. Draw its process flow with the triangles, and propose a change that would reduce the confusion.

Reflections

[Posted as a reflection exercise on the course’s website for students to write about in a journal due at the end of semester.]

1. There is a famous Chinese quote as follows:

谋事在人，
成事在天。
*Process belongs to humans,
outcomes belong to the heavens.*

—罗贯中 (Guanzhong Luo)

To what extent do you resonate with this sentiment? Provide concrete examples from your life to illustrate.

2. Why might it be difficult to write down a process flow for some processes you have been a part of, say, at a previous or current job?
3. Would you want your boss to know all of the processes you do at work? What about someone else in your group vying for a promotion you'd like to get?
4. Are there some tasks that you do regularly that you feel cannot (or possibly should not) be written down in the form of a process flow? Why do you feel this way?
5. Camila pushed back in class: why give ordinary things—the worker, the order, the cup—these special names at all? Think of a time in your own work or study when learning a new vocabulary. Did the words reveal something, or just relabel what you already saw?
6. Binesi left out the “pour coffee” step because she was picturing only what *she* had to do, not what the worker did. Whose labor do you routinely leave out of your own mental picture of how something gets to you?