5TH GRADE SYSTEMS CHALLENGE

Food Truck Tycoon

Teacher Facilitation Guide

Duration: ~1 Week (5 Class Periods)

CHALLENGE OVERVIEW

Students investigate how systems work by learning to read, interpret, and create flowcharts — a fundamental tool in engineering, computer science, and business operations. Beginning with playful physical activities and building toward a culminating flowchart of their own food truck process, students develop the ability to break any complex process into logical, ordered steps and to represent decisions clearly.

The Systems Challenge connects directly to the Data Challenge (students map the processes behind their food truck concept) and sets up the Design Challenge (students build a physical model of their food truck). It can also be implemented as a stand alone module.

BY THE END OF THIS CHALLENGE, STUDENTS WILL BE ABLE TO:

- Explain what a system is and identify its parts (inputs, process, outputs).
- Read and interpret a flowchart, following the logic from start to finish.
- Use the four core flowchart symbols correctly: oval, rectangle, diamond, and arrows.
- Distinguish between a simple sequence and a process that includes decision points and loops.
- Create an original flowchart representing a real process for their food truck.
- Debug a peer's flowchart by following it step by step and identifying gaps or ambiguities.

CHALLENGE STRUCTURE

- Activity 1 — What is a System? (Day 1)
- Activity 2 — Flowchart Symbols and Simple Sequences (Day 2)
- Activity 3 — The Decision Diamond (Day 3)
- Activity 4 — Mapping Your Food Truck Process (Day 4)
- Activity 5 — Building, Debugging, and Sharing Your Flowchart (Day 5)

MATERIALS

- Symbol Matching Cards and Symbol Key anchor chart.
- Plain paper and pencils for flowchart drafting (paper-first recommended).
- Sticky notes (two colors) for peer debugging and the gallery walk.
- Optional: Lucidchart or Google Drawings for groups working digitally.

Companion Handouts:

- Handout 1 — Flowchart Symbols Reference Card
- Handout 2 — The Grilled Cheese Protocol
- Handout 3 — Food Truck Flowchart Planning Template
- Handout 4 — Peer Debugging Checklist

STANDARDS ALIGNMENT

NGSS Engineering Design, Science and Engineering Practices & Computational Thinking

- **3-5-ETS1-1 —** Activities 4 and 5: Students define the food truck process they want to map, identify criteria for a successful flowchart (complete, unambiguous, logical), and iterate based on peer feedback.
- **SEP-2: Developing and Using Models —** Activities 2-5: A flowchart is a model of a process. Students interpret existing flowcharts, build their own, and use them to communicate how a system works.
- **SEP-6: Constructing Explanations —** Activity 5: Students use their flowchart to explain a food truck process to classmates during the gallery walk, answering questions about their design choices.
- **SEP-8: Obtaining, Evaluating, and Communicating Information —** Activities 3 and 5: Students evaluate peers' flowcharts by walking through the logic step-by-step and identifying gaps, ambiguous steps, or missing decisions.
- **Computational Thinking: Decomposition and Algorithms —** All activities: Students practice breaking a complex process into discrete, ordered steps — the core of algorithmic thinking and a foundational computing concept.

Common Core Math Practice

- **MP.1 Make sense of problems and persevere —** Mapping a real process (like a food truck recipe) requires students to think carefully about the order of steps and what could go wrong at each stage.
- **MP.3 Construct viable arguments —** Activity 5: Students defend their flowchart design choices during the gallery walk — why did they structure the process this way? What would happen if a step were removed?
- **MP.6 Attend to precision —** Flowcharts must be precise: missing an arrow, leaving a decision branch unlabeled, or skipping a step makes the whole chart unusable. Students practice precision through peer debugging in Activity 5.

KEY VOCABULARY	
Input	What goes INTO the system (ingredients, customers, money, energy).
Process	What HAPPENS inside the system — the steps and decisions that transform the inputs.
Output	What comes OUT of the system as a result (finished food, a served customer, a receipt).

ACTIVITY 1

What is a System?

Essential Question: How do the steps in a process connect to make a whole system work?

TIME
~60 min

Students are introduced to systems thinking: the idea that most real-world processes are made up of connected parts that depend on each other. Through a physical warm-up and the classic Human Robot activity, they discover firsthand that the order of steps matters — skip one, get the wrong result. The session ends by connecting systems to their food trucks.

SETUP & MATERIALS

- Prop ingredients for Human Robot demo: a jar with a lid (or pencil case), two pieces of paper to represent bread, and any object as a stand-in for peanut butter and jelly. No actual food needed — the point is to act out the steps literally.
- Optional: whiteboard or chart paper to write student instructions during the activity.
- Engineering Design Logs.

Part 1 — Warm-Up: Order Matters: 10 min

Ask students to think of a process they do every day. Call on a few students and ask: what is the first step? What happens if you do the last step first?

Quick examples to discuss as a class:

- Putting on shoes and socks: what goes wrong if you put the shoes on first?
- Sending a text: what happens if you hit Send before you type the message?
- Making instant noodles: what happens if you eat them before adding the hot water?

Land the key idea: most processes only work correctly if the steps happen in the right order. When we describe a process as a series of steps, that is called a sequence. Today we will see what happens when a sequence has a gap.

Part 2 — Human Robot Activity: 25 min

This activity makes the importance of precise, sequential instructions viscerally clear. It also introduces the idea that humans use natural common sense to fill in gaps — but machines (and flowcharts) cannot.

How to run it:

- Tell students: “I am a robot. I can only do exactly what you tell me, nothing more. Your job is to give me instructions to make a peanut butter and jelly sandwich.”
- Write each instruction on the board as students call it out. Follow each one literally and robotically. Classic moments to play up:
- If they say “put peanut butter on the bread” without saying to open the jar first, try to spread the closed jar across the paper.
- If they say “put the bread together,” put one piece on top of the other — upside down, or sideways.
- If they say “cut the sandwich in half,” ask: with what? Which way is half?
- After a few hilarious failures, let students revise their instructions. Guide them toward realizing that a good set of instructions leaves nothing to assumption.

DISCUSSION PROMPTS — HUMAN ROBOT

- *What happened when we followed the instructions exactly? Why?*
- *What would happen if a robot in a real factory followed imprecise instructions?*
- *What is the difference between instructions a human can follow and instructions a machine can follow?*
- *Can you think of a time in real life when following steps in the wrong order caused a problem?*

Part 3 — What is a System?: 20 min

Now broaden from sequences to systems. A system is a set of connected parts that work together to accomplish something. Systems have three key components:

Introduce these terms — students record them in their Engineering Design Logs:

KEY VOCABULARY	
Input	What goes INTO the system (ingredients, customers, money, energy).
Process	What HAPPENS inside the system — the steps and decisions that transform the inputs.
Output	What comes OUT of the system as a result (finished food, a served customer, a receipt).

Apply to the food truck context:

- What are the INPUTS to a food truck? (Ingredients, equipment, staff time, customer orders, money)
- What are the PROCESSES? (Cooking, serving, taking payment, restocking)
- What are the OUTPUTS? (Food, happy customers, revenue, waste)

Part 4 — Reflection: 5 min

- Can you name another system you interact with every day? What are its inputs, process, and outputs?
- Why is it important for the steps in a system to happen in the right order?
- What do you think would be the hardest part about explaining your food truck process to someone else?

ACTIVITY 2

Flowchart Symbols and Simple Sequences

Essential Question: How do symbols help us communicate a process clearly and precisely?

TIME
~50 min

Students learn the four core flowchart symbols, practice matching them to their roles, and build their first complete flowcharts — first together as a class, then independently using the Grilled Cheese Protocol (Handout 2). By the end of the session, every student has drawn at least one complete, working flowchart.

SETUP & MATERIALS

- Print and cut one set of Symbol Matching Cards per group (Handout 1).
- Prepare a “Symbol Key” anchor chart or slide to keep visible throughout the session and all remaining activities.
- Plain paper and pencils for individual flowchart practice.
- Optional: colored markers for students who want to color-code YES/NO paths.

Part 1 — Symbol Matching Warm-Up: 10 min

Give each group a set of Symbol Matching Cards. Students match each shape to its name and function. After 3-4 minutes, review as a class. Post the Symbol Key where all students can see it — it stays up for the rest of the challenge.

Shape	Name / Role	What It Means
Oval	START / END	Marks where the process begins and where it ends. Every flowchart has exactly one Start oval and at least one End oval.
Rectangle	Action / Process	An action or step — something you DO. Most steps in a flowchart are rectangles.
Diamond	Decision	A yes-or-no question. Two arrows leave the diamond — one labeled YES, one labeled NO. Each leads to a different next step.
Arrow	Flow / Direction	Connects shapes and shows which direction the process moves. Without arrows, the flow is lost.

TEACHER TIP

Students often confuse rectangles and diamonds at first. A helpful reminder: the diamond has a POINT at the top and bottom — it is sharp and decisive, like a yes-or-no question. The rectangle is steady and flat — it just describes an action.

Part 2 — Build a Flowchart Together: 20 min

Walk through building a simple flowchart as a class. Use an everyday process students know well. The goal is to get the symbols right and to see how arrows connect everything into a logical path.

Recommended example: "How to Brush Your Teeth"

TOOTHBRUSHING FLOWCHART — GUIDED BUILD

- Step 1: Draw an oval. Label it START.
- Step 2: Draw an arrow down to a rectangle: Get your toothbrush.
- Step 3: Rectangle: Put toothpaste on the brush.
- Step 4: Rectangle: Brush teeth for 2 minutes.
- Step 5: Rectangle: Rinse mouth.
- Step 6: Oval: END.

Now ask: where could a decision go in this process? For example: Is the toothpaste cap off? Do you need to rinse the brush first? Add a diamond and two branches.

Part 3 — Practice: Grilled Cheese Protocol: 20 min

Students now work individually or in pairs to build the Grilled Cheese flowchart from Handout 2. This example introduces the most important new concept: a decision diamond that creates a LOOP — the process goes back and checks again until the condition is met.

After students complete their flowchart, debrief as a class:

- Where is the loop in the Grilled Cheese flowchart? What causes it?
- What would happen if someone removed the decision diamond and just wrote 'wait 2 minutes'?
- Can you find a loop in a real process you do every day?

DISCUSSION PROMPTS — FLOWCHART SYMBOLS

- *What is the difference between a rectangle and a diamond?*
- *Why do arrows matter? What would happen if you forgot them?*
- *Every flowchart must have at least one oval. Why? Could it have more than one?*
- *What does a loop in a flowchart mean? Can you name a real-life loop?*

ACTIVITY 3

The Decision Diamond

Essential Question: How do decisions affect the path through a process — and what happens when things go wrong?

TIME
~50 min

Students go deeper with the decision diamond: they see how it creates branches (two different paths), how one branch often loops back, and how a missing or wrong decision can break an entire process. They build a decision-rich flowchart from a real context, then swap with a partner for a peer debugging session.

SETUP & MATERIALS

- Plain paper and pencils for flowchart building.
- Sticky notes (two colors if possible: one for 'I can follow this' and one for 'I got stuck here').
- Symbol Key from Activity 2 still posted.
- Optional: green and red markers for students to trace YES and NO paths in different colors.

Part 1 — Decision Diamond Deep Dive: 15 min

Revisit the decision diamond. A diamond always has exactly TWO exits: YES and NO (or True/False, or Done/Not Done). Each exit leads somewhere different — and one of them often loops back to repeat an earlier step.

Walk through this extended example as a class:

SCHOOL MORNING FLOWCHART — GUIDED BUILD

- START
- Rectangle: Alarm goes off. Wake up.
- Diamond: Is it a school day? → NO: Go back to sleep. END (for now).
- YES branch continues:
- Rectangle: Get dressed in school clothes.
- Rectangle: Eat breakfast.
- Diamond: Is your homework in your bag? → NO: Find homework and pack it. Loop back to this diamond.
- YES: Rectangle: Walk to bus stop or car.
- Diamond: Did the bus already leave? → YES: Call for a ride or walk. Continue.
- NO: Rectangle: Wait for the bus.
- END

Point out: the homework loop repeats until the answer is YES. This is how most real loops work: keep checking until the condition is met.

Part 2 — Build Your Own Decision Flowchart: 20 min

Students build their own decision-rich flowchart on a topic of their choice. They must include: at least one decision diamond, at least one loop, and a clear start and end.

Suggested topics:

- How to decide what to have for lunch
- How to get a video game character through a level
- How to handle it when a customer at your food truck is unhappy
- How to know if a food truck item is ready to serve
- Any process from their food truck concept

> **TEACHER TIP**
>
> *Encourage students to think about FAILURE PATHS — what happens when the answer is NO? A common mistake is to only draw the YES path and leave the NO branch hanging. Every diamond needs two labeled exits.*

Part 3 — Peer Debugging: 15 min

Students swap flowcharts with a partner and try to 'walk through' the chart — using their finger to follow each arrow exactly as drawn. If they get stuck, confused, or cannot find the next step, that is a bug. They leave a sticky note at the problem spot.

Debugging checklist for reviewers:

- Does the flowchart have a START oval and at least one END oval?
- Does every shape have at least one arrow coming in (except START) and one going out (except END)?
- Does every decision diamond have exactly two labeled exits (YES and NO)?
- Is every step clear enough that a stranger could follow it?
- Is there anything missing — a step you would expect to see that is not there?

> **DISCUSSION PROMPTS — PEER DEBUGGING**
>
> - *What bugs did you find in your partner's chart? Were they easy or hard to spot?*
> - *What was the most common problem: missing arrows, unlabeled diamonds, or missing steps?*
> - *How is debugging a flowchart similar to debugging computer code?*
> - *After seeing your partner's feedback, what is the first thing you would fix in your own chart?*

ACTIVITY 4

Mapping Your Food Truck Process

Essential Question: How can a flowchart help us understand and improve the way our food truck works?

TIME
~50 min

Students apply everything they have learned to a real challenge: choosing a food truck process to map and drafting their flowchart. They connect this work to the Engineering Design Process, identifying the process as the problem to solve and the flowchart as their engineered solution. By the end of the session, every group has a working draft — not yet polished, but complete enough to debug.

SETUP & MATERIALS

- Plain paper and pencils for flowchart drafts.
- Food Truck Flowchart Planning Template per group (Handout 3).
- Symbol Key still posted.
- Optional: access to Lucidchart (lucidchart.com, free for students) or Google Drawings for groups ready to work digitally.
- Class data charts or food truck notes from the Data Challenge (if available).

Part 1 — Connecting to the Engineering Design Process: 10 min

Briefly revisit the EDP. In this challenge, students are in the Ideate and Evaluate stages: they are designing a solution (the flowchart) to the problem of communicating how their food truck system works.

Frame the question for groups:

THE CHALLENGE

- Your food truck is a system. A system only runs smoothly if everyone on the team knows exactly what steps to follow — and what to do when something goes wrong.
- Your job: choose ONE process that happens at your food truck and map it as a complete, accurate flowchart. Someone who has never worked at your food truck should be able to follow it.

Part 2 — Choose Your Process: 10 min

Groups review the four process options and choose the one that best fits their food truck concept. They should pick a process they know well enough to describe every step — not so simple that it only has 3 steps, not so complex that it would take 30.

Process Option	Description	Possible Decision Points
Recipe Process	How to make one of your signature menu items from start to finish.	Is the item cooked through? Is it the right portion? Does it need toppings?
Customer Service Flow	What happens from the moment a customer approaches the truck to the moment they leave.	Is the item available? Does the customer want customizations? Is the order correct?
Opening / Setup Routine	The steps your food truck team takes to prepare the truck before the first customer arrives.	Are all supplies stocked? Is equipment working? Are temperatures safe?
Order Fulfillment	How a single order moves from being placed to being handed to the customer.	Is the order complete? Does it match what was requested?

TEACHER TIP

If students completed the Data Challenge, encourage them to choose a process directly tied to their food truck concept and menu. If this challenge is being taught standalone, let students invent a simple food truck concept (name and one menu item) just to have a context for their flowchart.

Part 3 — Draft Your Flowchart: 25 min

Groups use the Food Truck Flowchart Planning Template (Handout 3) to plan their flowchart before drawing it. The template asks them to:

- **Name the process:** What exactly does this flowchart show?
- **List the steps first:** Write out all the steps in order as a numbered list before drawing any shapes.
- **Mark the decisions:** Circle any step that involves a YES/NO choice.
- **Identify the loops:** Put a star next to any decision where NO means going back to an earlier step.

Once the template is complete, groups begin drawing. Remind them this is a draft — imperfect is fine. They will debug and refine in Activity 5.

DISCUSSION PROMPTS — DRAFTING YOUR FLOWCHART

- *What is your process called? What are the inputs and outputs?*
- *How many steps does your process have? Is that more or less than you expected?*
- *Where are the decision points — the moments when something could go differently?*
- *What would happen if you removed one step? Would the process still work?*

Part 4 — Digital Tools: ongoing

For groups who want to create a digital flowchart, two options are recommended. Both are free for students and work in a browser.

Tool	Notes for Teachers
Lucidchart (lucidchart.com)	Purpose-built for flowcharts and diagrams. Has drag-and-drop flowchart shapes. Free education accounts available. Exports easily to PDF or image. Recommended for students who want a polished digital result.
Google Drawings (drawings.google.com)	Available via Google Drive — no new account needed if students have Google Classroom access. Less specialized than Lucidchart but familiar. Use Insert > Shapes to find ovals, rectangles, and diamonds.

TEACHER TIP

Paper-first is recommended for drafting. Even students who plan to make a digital final version should sketch on paper first — it is faster to move shapes around with a pencil than to redo a digital layout from scratch.

ACTIVITY 5

Building, Debugging, and Sharing Your Flowchart

Essential Question: How can a clear flowchart help others understand and follow a complex process?

TIME
~60 min

Students complete and refine their flowcharts, then put them to the ultimate test: a Flowchart Gallery Walk where classmates try to follow each chart step-by-step and leave feedback. Flowcharts that can be followed without explanation pass. Those that confuse visitors get debugged and improved. The session closes by looking ahead to the Design Challenge.

SETUP & MATERIALS

- Completed flowchart drafts from Activity 4 (paper or digital).
- Peer Debugging Checklist per student (Handout 4).
- Two colors of sticky notes: one for ‘This works’ and one for ‘I got stuck here.’
- Tape to post flowcharts on walls or display on desks.
- Optional: computers or tablets for groups finishing a digital version.

Part 1 — Complete and Refine: 15 min

Groups review their drafts from Activity 4 and make final refinements. Prompt them to self-check against the flowchart requirements before the gallery walk:

- Every shape uses the correct symbol (oval for start/end, rectangle for actions, diamond for decisions).
- Every diamond has exactly two labeled exits: YES and NO.
- Every shape is connected by arrows — no dead ends.
- There is a clear START and at least one clear END.
- Every step is described clearly enough that a stranger could follow it.
- The process makes sense from beginning to end.

Part 2 — Flowchart Gallery Walk: 30 min

Post or display all flowcharts around the room. Students rotate through the displays with their Peer Debugging Checklist, spending 3-4 minutes per chart. They try to follow each chart with their finger, leaving sticky notes:

- **Green sticky note:** “I followed this step without getting confused.”
- **Yellow sticky note:** “I got stuck or confused here — here is what was unclear.”

After the gallery walk, groups return to their own chart, read the sticky notes, and make any final fixes.

TEACHER FACILITATION NOTES — GALLERY WALK

- Circulate and watch for charts where multiple visitors left yellow notes at the same spot — that is a reliable signal that something needs to be fixed.
- If a group’s chart is consistently passing (all green notes), challenge them: can they add one more decision diamond to make the process more realistic?
- If a group’s chart is completely stuck, do a quick 1:1 coaching session: ask them to walk you through the chart verbally first, then help them see where the diagram does not match their verbal explanation.

Part 3 — Reflection: 15 min

Use these as a whole-class discussion or written reflection:

- What is the most important thing a flowchart must have to be useful?
- What was the hardest part of your flowchart to get right? How did you fix it?
- What did you learn about your food truck process by having to draw it out step by step?
- How could a real food truck owner use a flowchart like yours?
- If you were going to add one more decision diamond to your flowchart, where would it go and what would it ask?

LOOKING AHEAD — THE DESIGN CHALLENGE

You have decided what your food truck sells and mapped how it works. Now it is time to design the physical space. In the Design Challenge, you will create a scaled floor plan of your food truck in TinkerCAD and build a cardboard model. A good flowchart of your customer service process might just tell you exactly what equipment and space you need inside your truck.

Companion Handouts

Handout 1 — Flowchart Symbols Reference Card

Print one per student or display as a classroom poster. Students keep this as a reference throughout Activities 2-5.

FLOWCHART SYMBOLS — QUICK REFERENCE

- **OVAL (Start / End):** Every flowchart begins with a START oval and ends with an END oval.
- **RECTANGLE (Action / Step):** Something you DO. Most steps in a process are rectangles.
- **DIAMOND (Decision):** A YES or NO question. Has exactly two labeled exits: YES and NO.
- **ARROW (Flow Direction):** Connects shapes. Shows which step comes next. Do not forget them!

Tip: Color-code your YES paths in green and your NO paths in red to make loops easier to trace.

Handout 2 — The Grilled Cheese Protocol

A complete flowchart example for students to practice reading and building in Activity 2, Part 3. Adapted for 5th-grade readability. Key learning: the decision loop — the process repeats until the condition is met.

THE GRILLED CHEESE PROTOCOL

[START — oval] You want a grilled cheese sandwich.

[ACTION — rectangle] Put butter on one side of two slices of bread.

[ACTION — rectangle] Place one slice butter-side DOWN in a cold pan.

[ACTION — rectangle] Add cheese slices on top of the bread in the pan.

[ACTION — rectangle] Place the second slice on top, butter-side UP.

[ACTION — rectangle] Turn the stove to medium heat.

[DECISION — diamond] Is the bottom bread golden brown and crispy?

NO path: Wait 30 seconds. Go back to CHECK.

YES path: Continue to next step.

[ACTION — rectangle] Use a spatula to FLIP the sandwich.

[DECISION — diamond] Is the cheese melted and the second side golden?

NO path: Wait 30 seconds. Go back to CHECK.

YES path: Continue to next step.

[ACTION — rectangle] Turn off the stove. Move sandwich to a plate.

[ACTION — rectangle] Slice diagonally.

[END — oval] Eat and enjoy!

The loop: Both CHECK diamonds send the NO path back to wait and re-check. This is the core of a loop: keep repeating until the answer changes to YES.

Handout 3 — Food Truck Flowchart Planning Template

One per group. Students complete this in Activity 4 before drawing their flowchart. The planning template helps students think through the process in words before committing to shapes and arrows.

FOOD TRUCK FLOWCHART — PLANNING TEMPLATE

Food Truck Name: _____

Process to Map: _____

Process Start (what triggers this process?):

_____

Process End (what does success look like?):

_____

Step 1: List all the steps in order (use as many rows as you need):

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

Step 2: For each decision (Y above), write the YES path and the NO path:

Decision 1 — YES leads to: _____

NO leads to: _____

Decision 2 — YES leads to: _____

NO leads to: _____

Step 3: Are there any loops (steps where NO sends you back to repeat an earlier step)? Y / N

If yes, which decision(s)? _____

Handout 4 — Peer Debugging Checklist

One per student for Activity 5. Students use this while walking through a classmate's flowchart.

Flowchart you are reviewing: _____

Your name: _____

☐ The flowchart has a START oval.

☐ The flowchart has at least one END oval.

☐ Every shape has at least one arrow coming IN (except START).

☐ Every shape has at least one arrow going OUT (except END).

☐ Every decision diamond has exactly TWO labeled exits: YES and NO.

☐ Every step is clear enough that I know what to do next.

☐ The process makes sense from beginning to end.

☐ I was able to follow it from START to END without getting stuck.

One thing that works well: _____

One thing to improve: _____

A step or arrow I could not find or follow:

_____

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