

Part II — Feedback

Delays, External Drivers, and Competing Loops

Online, with a lab for each exercise: thinking-in-diagrams.aryehnielsen.com

Causal loops Part II · Feedback · Chapter 5 of 12 · the second of two chapters on causal loops

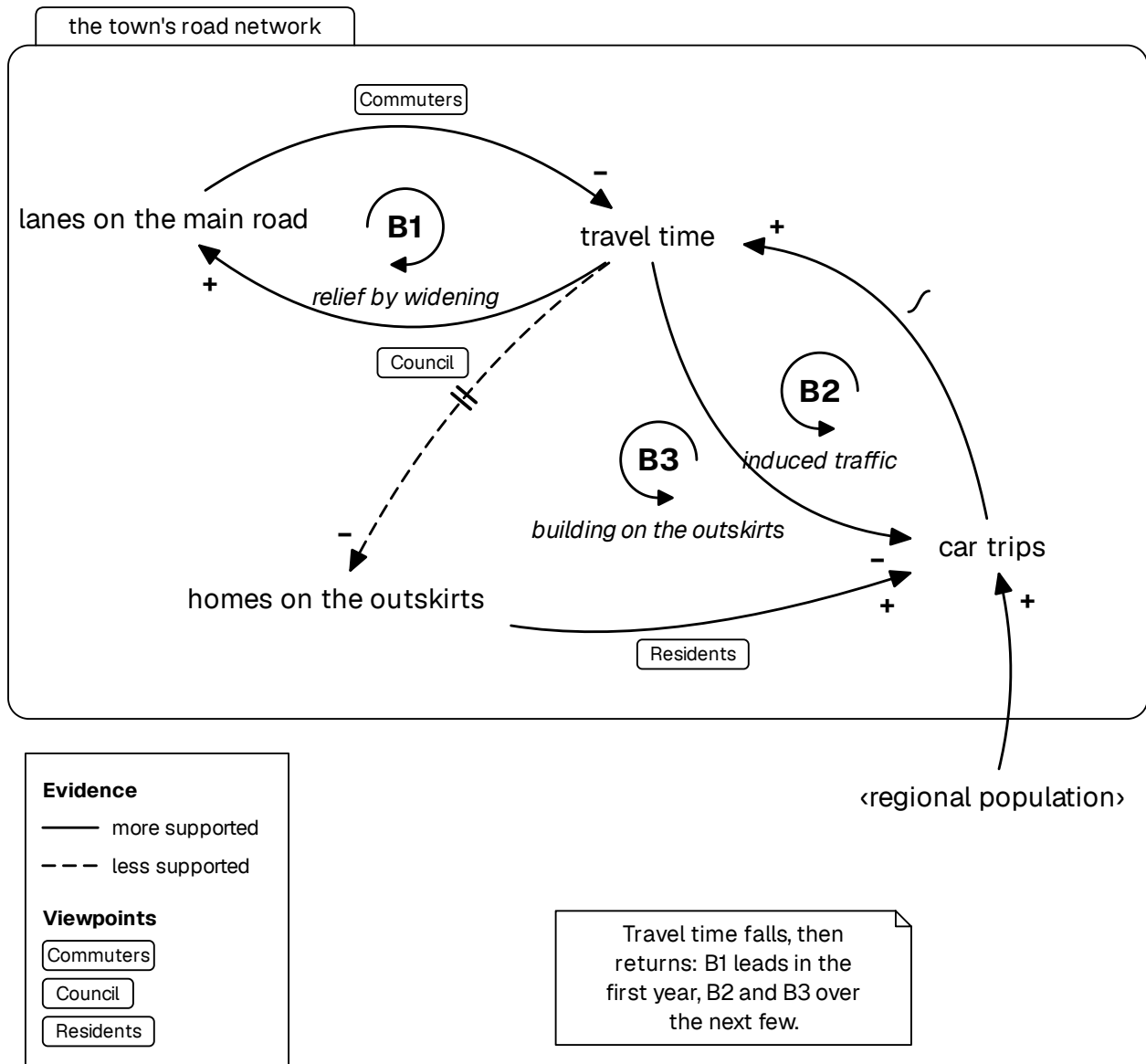
Why does the obvious fix make things worse? A fix can set off loops that pull back against it, some of them after a delay. A causal loop diagram shows what those loops are, what drives them from outside, and which of them leads when.

A town widens its main road

A town's main road jams every morning, so the council widens it from two lanes to four. For a year the drive across town takes twelve minutes instead of twenty-five.

Then the road fills. People who had taken the bus, driven at other hours or stayed home drive at rush hour.

Developers build estates on the outskirts, sold on the short drive into town, and their residents drive the main road too. Meanwhile the region's population grows, as it did before the widening. By the fifth year the drive takes twenty-five minutes again, with twice as many cars, and the council proposes six lanes.



What the notation expresses

Boundaries

A boundary thinking-in-diagrams.aryehnielsen.com/framing/drawing-the-boundary/#the-boundary, a named outline with a tab, marks what the model explains. The road diagram's boundary is *the town's road network*, around the lanes, travel time, car trips and homes on the outskirts.

External drivers

An **external driver** is a variable outside every boundary that affects something inside and isn't affected back. Its name is drawn in angle brackets: *<regional population>*. People move to the region for its jobs and housing, and nothing in the town's road network changes how many come, so regional population sits outside the boundary with one effect leaving it, into car trips.

An **external entity** thinking-in-diagrams.aryehnielsen.com/framing/drawing-the-boundary/#external-entities also sits outside a boundary, but it is a party, not a quantity, and exchanges run to it as well as from it; it is drawn only in system context maps, which have no variables, so the two never share a diagram.

CHECK YOUR UNDERSTANDING

In the road diagram, shorter travel times bring more homes on the outskirts, and more homes bring more car trips. Should homes on the outskirts be drawn as an external driver?

- a Yes: the homes are on the outskirts, outside the town
- b No: travel time affects them, so they belong inside the boundary
- c Yes: developers decide what gets built, not the council
- d Only once the homes outnumber the town's own

Feedback: Answers, chapter 5

Nonlinear effects

A **nonlinear effect** is weak over part of its range and sudden over another, or strong, then flat. It's drawn with a small S beside the effect's middle.

On a half-empty road, more car trips barely change travel time; near the road's capacity, each extra car adds minutes. The point where an effect turns from weak to sudden is its **threshold**: here, the road's capacity. Widening raised the threshold, so for a while more trips cost almost no time, and that drew the trips back.

Evidence coding

In a diagram with a dashed effect, solid marks an effect its author judges more supported, and dashed marks one less supported, a hypothesis; a diagram with no dashed effect carries no coding (chapter 1 thinking-in-diagrams.aryehnielsen.com/framing/what-is-a-diagram-for/#evidence-coding). In the road diagram, travel time → car trips is solid: induced traffic has been counted across American cities. Travel time → homes on the outskirts is dashed: the estates may have come for the short drive or for cheap land.

Viewpoint tags

A **viewpoint tag** is a small labeled box beside an effect, naming a stakeholder who stresses that effect. The tag marks emphasis, not a different structure.

Commuters stress lanes on the main road → travel time, the drive the widening shortened. Residents along the main road stress homes on the outskirts → car trips, the traffic past their doors. The council stresses travel time → homes on the outskirts, the new estates and their taxes.

The legend

The **legend** is a box listing a diagram's codings; any diagram with a dashed effect or a viewpoint tag must have one. Its evidence entry shows a solid line for more supported and a dashed line for less supported. Its viewpoints entry lists every viewpoint tag the diagram uses.

Loop dominance

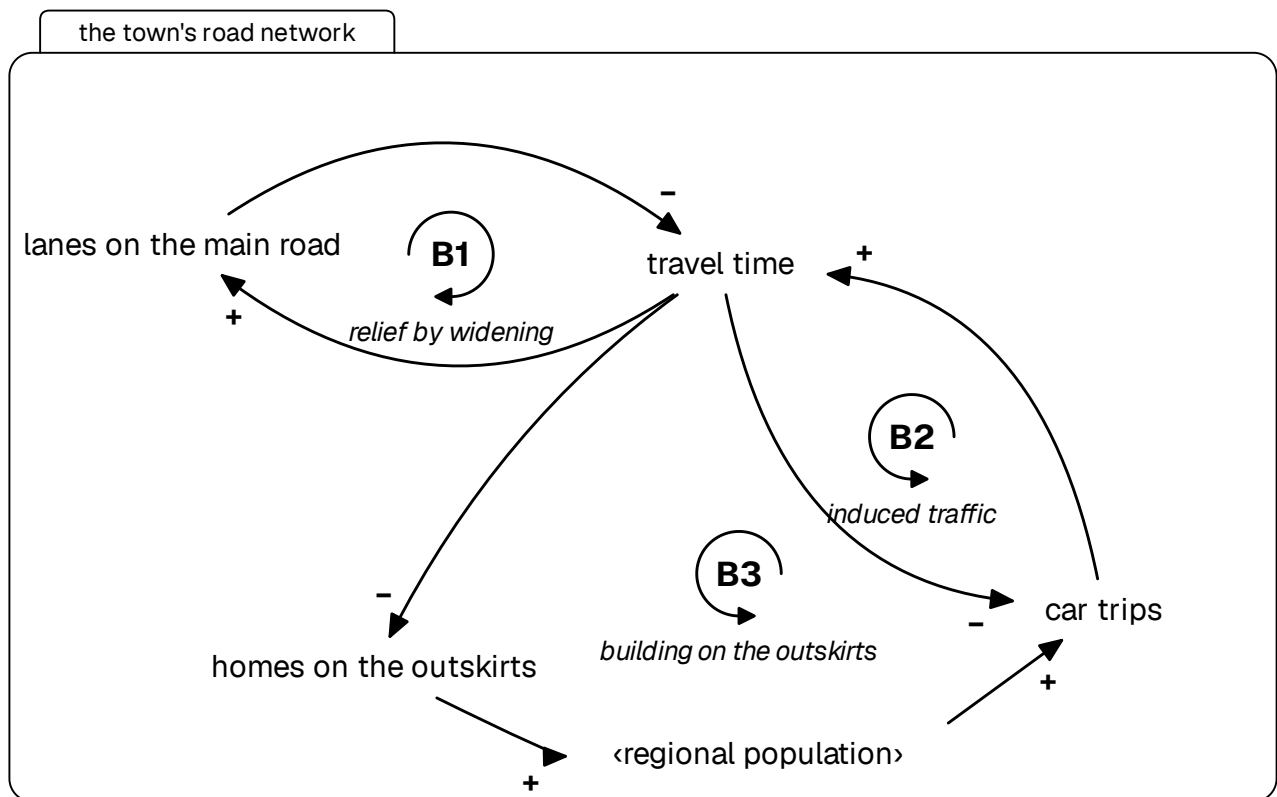
Loop dominance is which loop drives behavior at a given time. It is a reading of the structure, not a mark; the road diagram's behavior note names which loop leads first and which later.

In the first year B1, *relief by widening*, dominates: four lanes cut travel time. B2, *induced traffic*, changes travel time within months, as shorter drives draw trips back. B3, *building on the outskirts*, changes it over years, through the delay on new homes. By the fifth year B2 and B3 dominate.

All three loops are balancing, toward *different* levels: B1 moves travel time toward what the council will accept, B2 and B3 toward what motorists will put up with. A fix that a system's own loops pull back is **policy resistance**. Six lanes would set off B2 and B3 again.

The bad diagram

What's wrong with this diagram of the widened road?

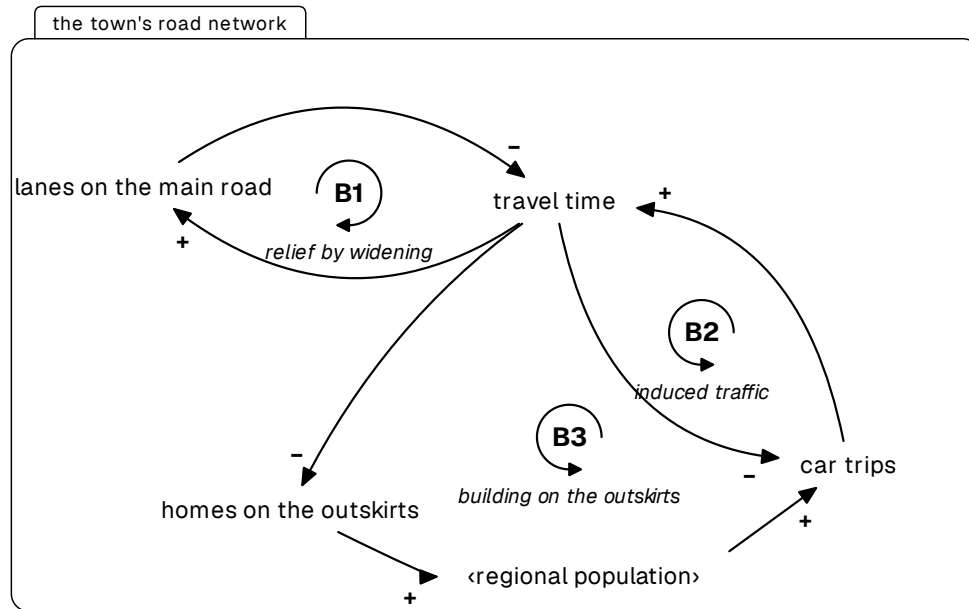
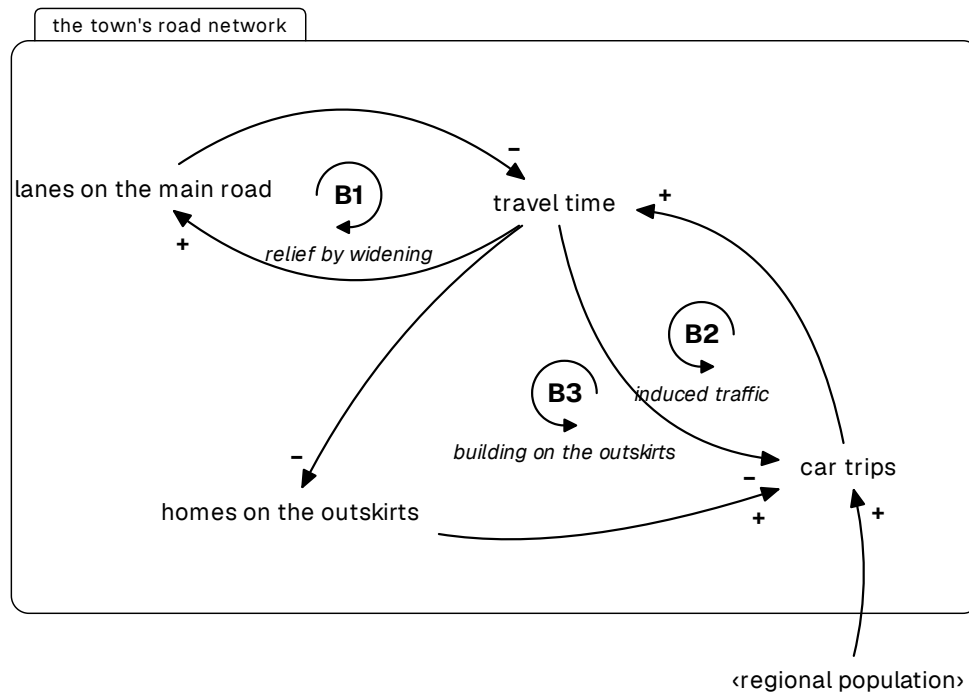


Regional population, marked external, sits inside the boundary with an effect running into it from homes on the outskirts, since new homes house new people, and B3 runs through it. The lab's check reports:

An external driver affects the system from outside and is not affected back, but 1 effect runs into one: homes on the outskirts → regional population. Remove that effect, or bring the variable inside the system by unmarking it as an external driver.

The corrected diagram

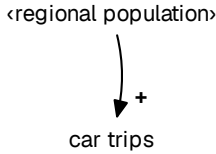
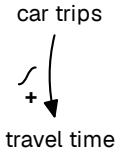
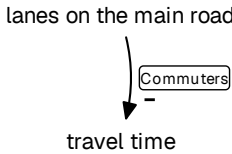
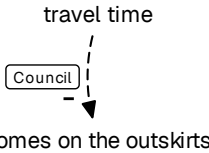
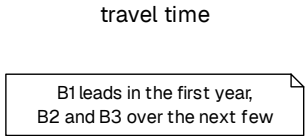
Corrected, homes on the outskirts run straight into car trips, and regional population sits outside the boundary, with its one effect leaving it.

Bad diagram**Corrected diagram**

Labels unchanged. 1 variable moved outside the boundary. Effects: 1 added, 1 removed. Loops: 1 changed.

B3 now closes inside the town's road network. If the estates do draw people to the region, regional population belongs inside the boundary, unmarked.

Notation moves

Notation move	When	What it shows	Example
Mark an external driver	A variable affects the inside and nothing inside affects it	A change the model doesn't explain	<i>«regional population»</i> → car trips
			
Mark a nonlinear effect	An effect is weak over part of its range and sudden over another	Where a threshold lies	car trips → travel time, at the road's capacity
			
Tag a viewpoint	Stakeholders stress different effects	Who stresses which effect, on one structure	<i>Commuters</i> on lanes on the main road → travel time
			
Add a legend	An effect is dashed or tagged	The codings in use	<i>Evidence, Viewpoints</i>
 Evidence — more supported - - - less supported Viewpoints Council			
Name loop dominance in a behavior note	Loops lead at different times	Which loop leads first and which later	<i>B1 leads in the first year, B2 and B3 over the next few</i>
			

Common misreading

Read one way, policy resistance means no fix works. The road diagram shows which loops pull widening back, and so where a fix could act on them: a charge for driving at rush hour weakens B2, so shorter drives draw fewer trips back.

Read the other way, a causal loop diagram is a set of separate effects, each judged alone. Lanes on the main road → travel time is true, and alone it means a shorter drive; the drive lengthens again through the loops it sits in.

The strongest objection

A causal loop diagram doesn't show accumulation. Homes on the outskirts pile up while drives are short and stay when drives lengthen, but a – effect from travel time can't show that, so a reader can't work out from the diagram which loop dominates when (Richardson, 1986). In experiments, business school students misjudge how the water in a bathtub changes as it flows in and drains out (Booth Sweeney and Sterman, 2000).

A behavior note is a prediction, not a derivation; stock & flow diagrams, from chapter 6, show accumulation and give numbers. Without them, the loop diagram still shows which loops exist and which way each moves travel time: widening sets off two loops against it.

Check your understanding

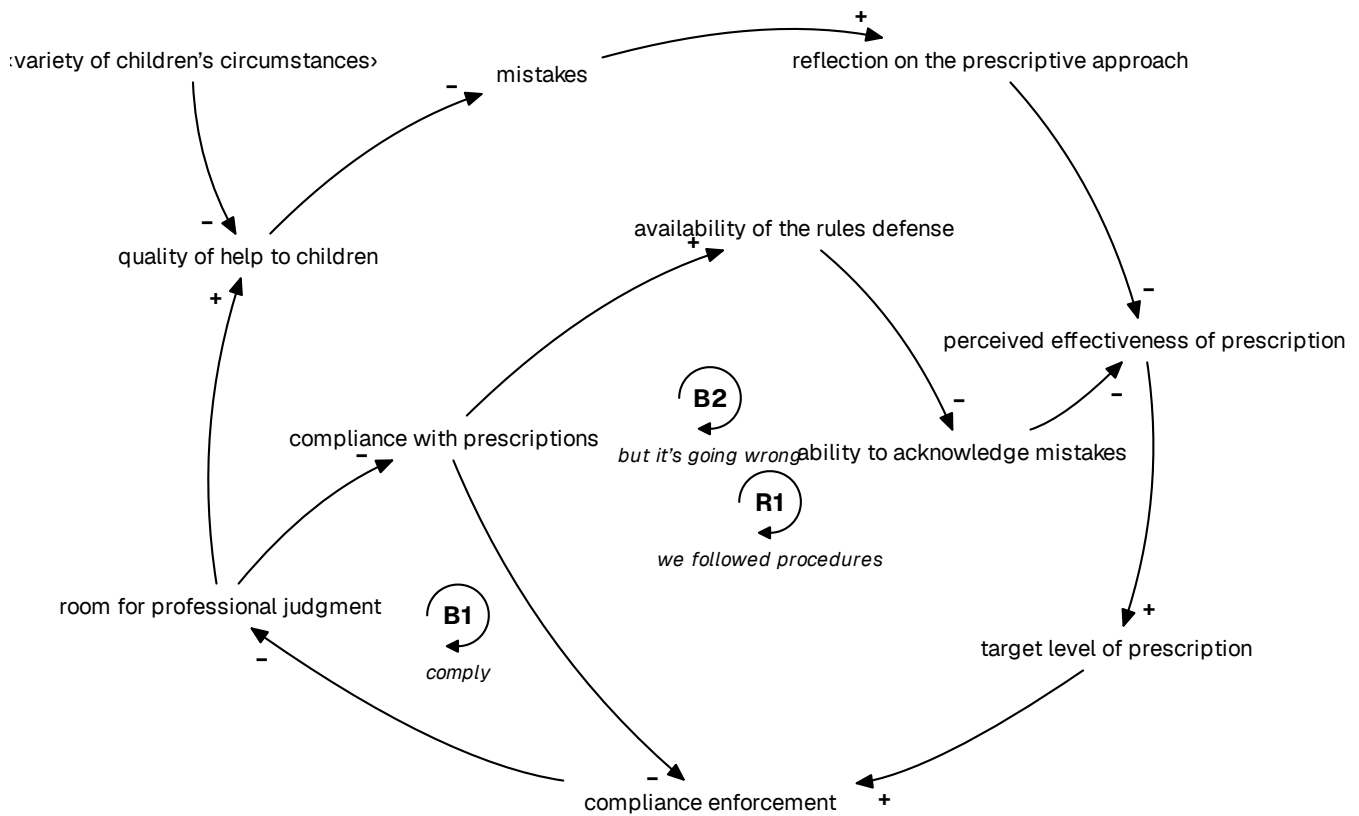
CHECK YOUR UNDERSTANDING

Five years after the widening, travel time is back where it was. Suppose the regional population hadn't grown at all. Which reading of the road diagram fits?

- a** B1 never moved travel time: widening did nothing
- b** B1 led at first; B2 and B3 led once trips and homes had grown
- c** A reinforcing loop formed somewhere in the town
- d** Travel time came back through the external driver

Feedback: Answers, chapter 5

The Munro Review's loops of compliance, redrawn



Redrawn from Eileen Munro, *The Munro Review of Child Protection, Part One: A Systems Analysis* (Department for Education, 2010) assets.publishing.service.gov.uk/media/5a81e8a5e5274a2e8ab567a9/TheMunroReview-Part_one.pdf, Appendix 2, the diagram on p. 52. Contains public sector information licensed under the Open Government Licence v3.0 www.nationalarchives.gov.uk/doc/open-government-licence/version/3/.

Its S (same direction) and O (opposite direction) drawn as + and -; its R labeled R1, and each loop's name lowercased, its exclamation mark dropped; nine names shortened or reworded; variety of children's circumstances marked as an external driver; its four-variable tail, from sense of satisfaction derived from work to public status of child protection workers, left out.

QUESTION 1 OF 3

Which variable is drawn as an external driver, in angle brackets, and why?

- a Variety of children's circumstances: it changes the quality of help, and nothing drawn changes it.
- b Target level of prescription: government sets it, from outside the profession.
- c Mistakes: they arise in children's lives, outside any office.

QUESTION 2 OF 3

In the review's account, R1, we followed procedures, keeps B2, but it's going wrong, from bringing the target level of prescription down. Where do the two loops compete?

- a** At compliance enforcement, where B1, comply, joins them.
- b** At mistakes, which R1 brings down.
- c** At perceived effectiveness of prescription: mistakes bring it down through reflection, while the rules defense holds it up.

QUESTION 3 OF 3

No effect in the figure carries a delay. On which effect would a delay belong?

- a** Compliance enforcement → room for professional judgment.
- b** Quality of help to children → mistakes.
- c** Room for professional judgment → compliance with prescriptions.

Feedback: Answers, chapter 5

Exercises

Passing the checks means meeting the brief, not being right. The answer to CL 08, *a parent who finishes the homework*, has the structure of shifting the burden

thinking-in-diagrams.aryehnielsen.com/pattern-and-judgment/structures-that-recur/#shifting-the-burden, an archetype in chapter 10.

CL 06 A food bank in a downturn

Multiple loops and a boundary

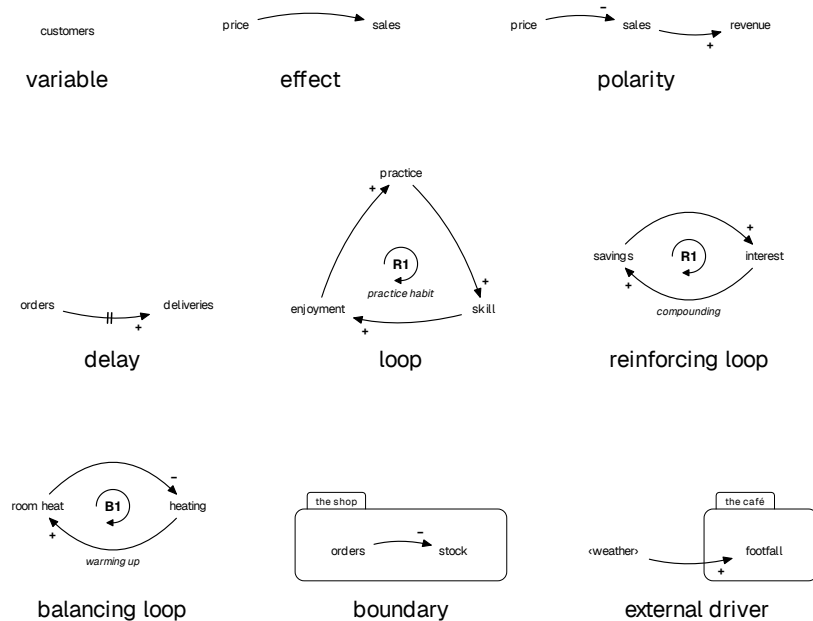
Reasoning ●●●○○ 3 of 5 Polish ●●●●○ 4 of 5

Layoffs at local employers reach a volunteer food bank months later, as families' savings run out. The food bank recruits volunteers, but the regulars give up shifts to train them, so more need goes unmet until trained volunteers take shifts weeks later. Keep layoffs outside the food bank's boundary.

The brief

- ☐ Draw the food bank's boundary and name it.
- ☐ Include one external driver.
- ☐ Show two delays.
- ☐ Close two loops and name each one.

Your palette



Draw here

CL 07 Antibiotics and the resistance they breed

Policy resistance

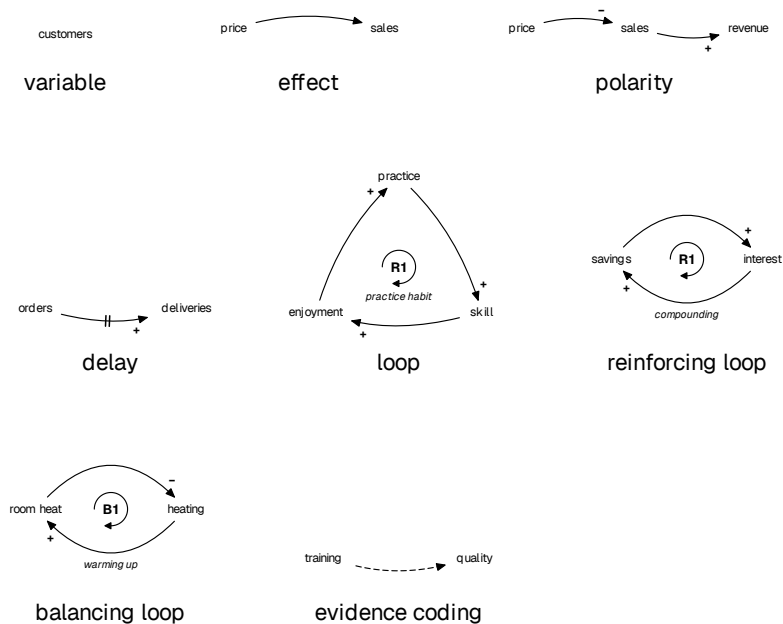
Reasoning ●●●●○ 4 of 5 Polish ●●●●○ 4 of 5

Doctors prescribe antibiotics to cure infections, and cures bring infections down. Over years, heavy use breeds resistant bacteria: treatments fail, infections spread, and prescribing rises. Drug makers might answer the failures with new antibiotics a decade later, but new antibiotics earn little, so that effect is uncertain.

The brief

- ☐ Draw at least three loops.
- ☐ Make the loops interact by sharing variables.
- ☐ Code at least one uncertain effect as a hypothesis.
- ☐ Code an effect as a hypothesis only where you are unsure of it.
- ☐ Keep the evidence legend small and inside the canvas.

Your palette



Draw here

CL 08 A parent who finishes the homework

Shifting the burden archetype

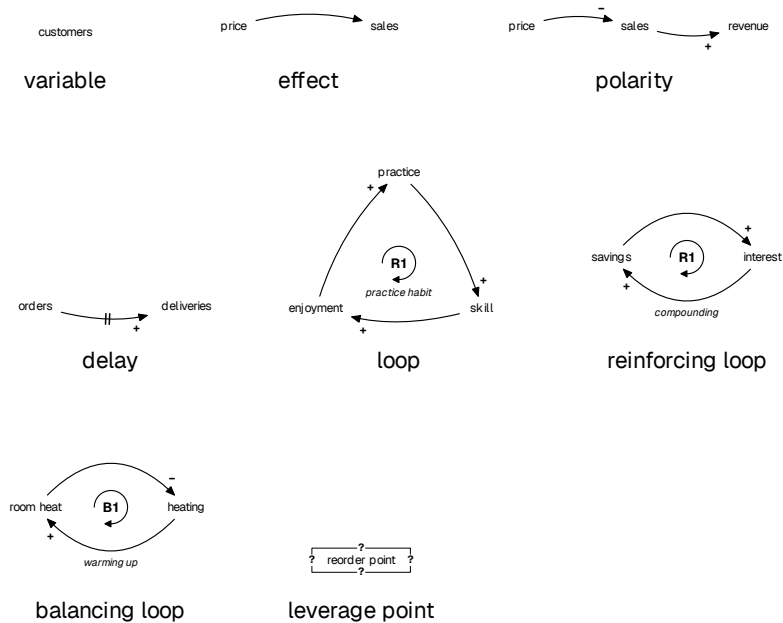
Reasoning ●●●●○ 4 of 5 Polish ●●●●○ 4 of 5

A child stuck on homework turns to a parent, who on rushed evenings finishes it. Tonight's homework gets done, but the child comes to rely on the help and tries less, and the skill that would let the child finish alone builds only over weeks.

The brief

- ☐ Use the shifting-the-burden structure.
- ☐ Close two balancing loops: the quick relief and the slower fundamental response.
- ☐ Close a reinforcing loop through which the relief builds dependence.
- ☐ Show the relief crowding out the fundamental response with a – effect.
- ☐ Name every loop by behavior, not topic.
- ☐ Create a clear visual hierarchy: main story first, detail second.

Your palette



Draw here

CL 09 An old town and its visitors

Competing viewpoints and nonlinear pressure

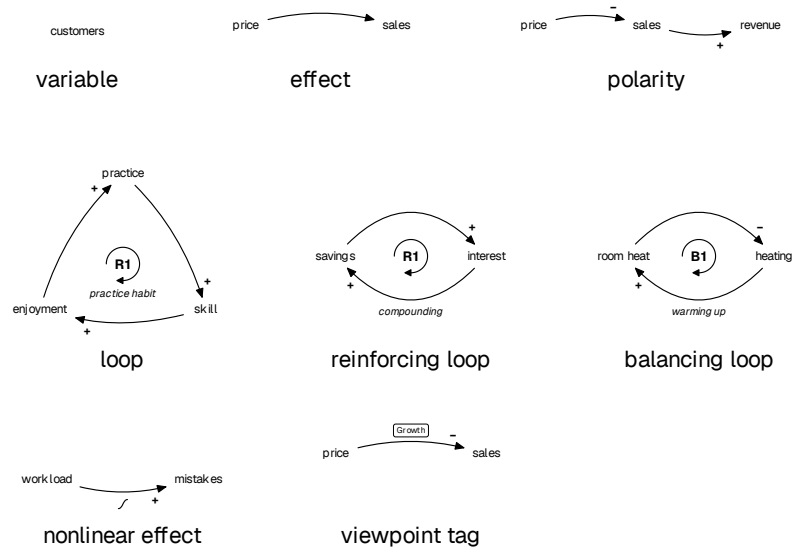
Reasoning ●●●●● 5 of 5 Polish ●●●●● 5 of 5

Visitors to an old town fill holiday lets, and more lets draw more visitors; the council limits lets as crowding grows. Residents leave as lets replace homes and as crowding rises: slowly, then fast once summer visitors outnumber them. Local shops close, and more residents leave. Tag what residents, shopkeepers and the council each stress.

The brief

- ☐ Include two reinforcing loops: visitor growth and the loss of residents.
- ☐ Include a balancing control loop.
- ☐ Mark one threshold as a nonlinear effect.
- ☐ Tag three viewpoints without using color.

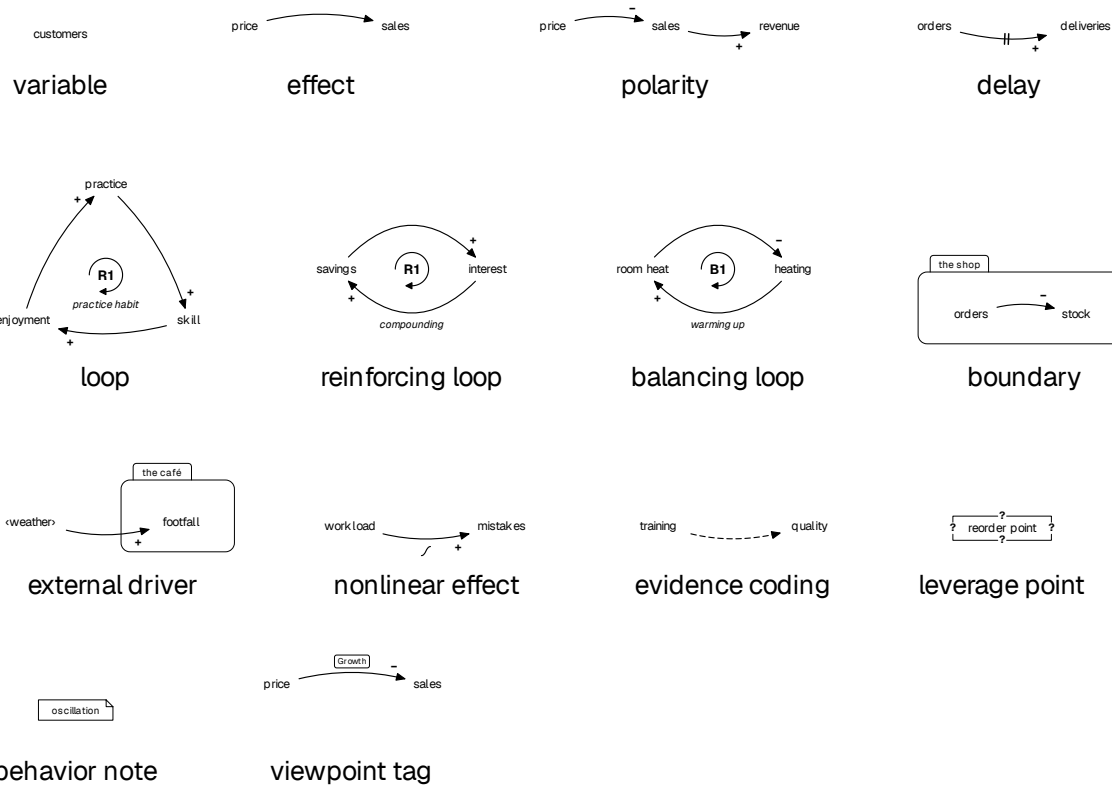
Your palette



Draw here

CL 10 A forest region and its fires

Your palette



CL 10 A forest region and its fires

Publication-ready multi-loop model

Reasoning ●●●●● 5 of 5 Polish ●●●●● 5 of 5

Small fires once thinned a dry forest's undergrowth. Crews now put out small and severe fires alike, so dry fuel builds for decades and the fires that escape burn hotter. Drought years make severe fires likelier. Whether severe fires lead agencies to fund prescribed burns, which thin the fuel, is uncertain.

The brief

- ☐ Synthesize four or more named loops.
- ☐ Add drought years as an external driver, outside a named boundary.
- ☐ Use evidence coding, declared in the legend.
- ☐ Polish spacing, label placement, and reading order.

Your palette

On the page before this sheet.

Draw here

Grid area for drawing the causal loop diagram.

CS 05 Kelsham Primary School: births, new homes and two loops**Your palette**

customers

variable

price → sales

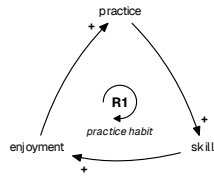
effect

price $\xrightarrow{-}$ sales $\xrightarrow{+}$ revenue

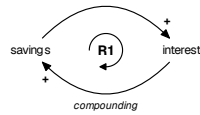
polarity

orders $\xrightarrow{+}$ deliveries

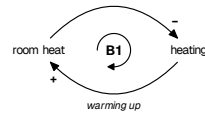
delay



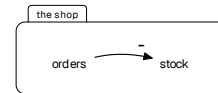
loop



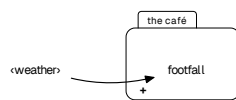
reinforcing loop



balancing loop



boundary



external driver

CS 05 Kelsham Primary School: births, new homes and two loops

External drivers, a delay of four years and competing loops

Reasoning ●●●○○ 3 of 5 Polish ●●●○○ 3 of 5

David Brennan forecasts Kelsham Primary School's starters from the births in its villages four years before. Births fell from 22 in 2016 to 11 in 2025, so the starters go on falling until 2029, whatever the school does. The first of the 60 homes at Mill Lane will be lived in from 2027, and he forecasts 0.25 children of primary school age for each, 15 children in all, joining in any year group. Inside the school, its funding still follows its pupils a school year behind each October count, and parents still weigh mixed-age classes against small ones. Draw the loops through the roll inside the school's boundary, with births and the new homes outside it.

The brief

- ☐ Draw the school's boundary and name it.
- ☐ Keep births in the villages and the homes at Mill Lane outside it as external drivers.
- ☐ Mark the four years from births to starters, and the October count, as delays.
- ☐ Close one reinforcing loop through the school's funding.
- ☐ Close one balancing loop through class size.
- ☐ Let the two loops share variables, so they compete.
- ☐ Name each loop by what it does.

Your palette

On the page before this sheet.

Draw here

Diagram drawing area with a grid of dots.

Sources

- John D. Sterman, *Business Dynamics: Systems Thinking and Modeling for a Complex World* (Irwin/McGraw-Hill, 2000), chapter 1, on policy resistance, and chapter 5, on causal loop diagrams of road building and traffic.
- John D. Sterman, “System Dynamics Modeling: Tools for Learning in a Complex World” doi.org/10.2307/41166098, *California Management Review* 43, no. 4 (2001), on policy resistance, with road building among its examples.
- Gilles Duranton and Matthew A. Turner, “The Fundamental Law of Road Congestion: Evidence from US Cities” doi.org/10.1257/aer.101.6.2616, *American Economic Review* 101, no. 6 (2011), measuring how driving rises with new lanes.
- George P. Richardson, “Problems with Causal-Loop Diagrams” doi.org/10.1002/sdr.4260020207, *System Dynamics Review* 2, no. 2 (1986), on what loop diagrams can’t show about accumulation.
- Linda Booth Sweeney and John D. Sterman, “Bathtub Dynamics: Initial Results of a Systems Thinking Inventory” doi.org/10.1002/sdr.198, *System Dynamics Review* 16, no. 4 (2000), on how people misjudge accumulation.
- Donella H. Meadows, *Thinking in Systems: A Primer* (Chelsea Green, 2008), chapter 2, on shifting dominance; chapter 4, on nonlinearities; chapter 5, on policy resistance.

Answers

Chapter 5 · Delays, External Drivers, and Competing Loops

In the road diagram, shorter travel times bring more homes on the outskirts, and more homes bring more car trips. Should homes on the outskirts be drawn as an external driver?

- a Yes: the homes are on the outskirts, outside the town
Not quite. Where a thing sits on a map doesn't decide it. The boundary marks what the model explains, and the model explains these homes: travel time changes them.
- b No: travel time affects them, so they belong inside the boundary
Yes. An external driver affects the inside and isn't affected back. An effect runs from travel time into homes on the outskirts, so they're part of what the model explains, and of loop B3.
- c Yes: developers decide what gets built, not the council
Not quite. Who decides doesn't settle it. What settles it is whether anything inside the boundary changes the variable, and travel time does.
- d Only once the homes outnumber the town's own
Not quite. Size doesn't make a variable external. One homeowner or ten thousand, an effect into it from inside the boundary keeps it inside.

Five years after the widening, travel time is back where it was. Suppose the regional population hadn't grown at all. Which reading of the road diagram fits?

- a B1 never moved travel time: widening did nothing
Not quite. Travel time fell in the first year, so B1 led then; other loops took over later.
- b B1 led at first; B2 and B3 led once trips and homes had grown
Yes. That's the shift in loop dominance the behavior note names. B2 changes travel time within months and B3, through its delay, over years; both pull travel time back toward the level motorists will put up with.
- c A reinforcing loop formed somewhere in the town
Not quite. Every loop in the diagram is balancing: each has one – effect. Travel time returning to a level, rather than growing without end, is what balancing loops produce.
- d Travel time came back through the external driver
Not quite. With the regional population flat, nothing outside the boundary changed: the town's own loops brought travel time back.

QUESTION 1 OF 3

Which variable is drawn as an external driver, in angle brackets, and why?

- a Variety of children's circumstances: it changes the quality of help, and nothing drawn changes it.
Yes. Children's circumstances vary for reasons no rule or target reaches, so no effect runs into it. Its one effect leaves it: the wider the variety, the less help a fixed procedure gives.
- b Target level of prescription: government sets it, from outside the profession.
Not quite. Perceived effectiveness of prescription changes the target through a + effect, so the target sits inside B2 and R1. An external driver has no effect running into it.
- c Mistakes: they arise in children's lives, outside any office.
Not quite. Quality of help changes mistakes through a – effect, and mistakes change reflection on the prescriptive approach: mistakes sit inside B2.

QUESTION 2 OF 3

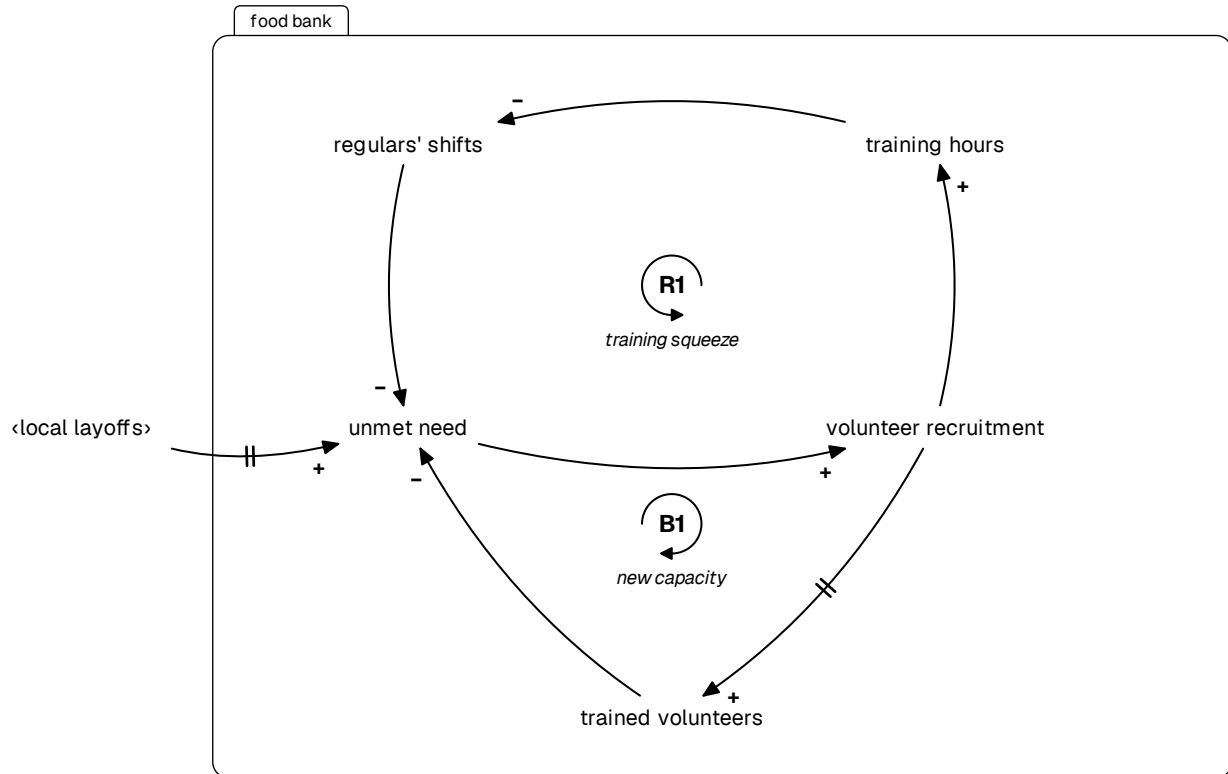
In the review's account, R1, we followed procedures, keeps B2, but it's going wrong, from bringing the target level of prescription down. Where do the two loops compete?

- a At compliance enforcement, where B1, comply, joins them.
Not quite. B2 and R1 both reach enforcement the same way, from the target. They pull apart earlier, at perceived effectiveness of prescription, which each changes through its own – effect.
- b At mistakes, which R1 brings down.
Not quite. R1 doesn't run through mistakes. It changes whether mistakes are acknowledged, and so meets B2 at perceived effectiveness of prescription.
- c At perceived effectiveness of prescription: mistakes bring it down through reflection, while the rules defense holds it up.
Yes. Two – effects end there. Through B2, more mistakes bring more reflection and lower it; through R1, more compliance makes the rules defense more available, mistakes harder to acknowledge, and raises it. While R1 dominates, the target stays high whatever the mistakes.

QUESTION 3 OF 3

No effect in the figure carries a delay. On which effect would a delay belong?

- a Compliance enforcement → room for professional judgment.
Not quite. An enforced rule narrows what a social worker may do from the day it applies: the change in room follows the change in enforcement with no delay to mark.
- b Quality of help to children → mistakes.
Yes. A mistake in the help given is found when harm to a child comes to light, often months or years later: the change in mistakes comes long after the change in quality of help. With that delay, B2 corrects slowly, and R1 has time to dominate.
- c Room for professional judgment → compliance with prescriptions.
Not quite. Compliance is, in the review's words, "the proximal effect" of a cut in that room: the change in compliance follows the change in room with no delay to mark.

CL 06 A food bank in a downturn

This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Layoffs raise unmet need months later. Recruiting answers it, but training takes the regulars off their shifts before trained volunteers arrive, so unmet need grows before it falls.

Why it works

- Layoffs outside the boundary, with no effect into them
- Two delays: savings running out, and training
- Training squeeze reinforcing, new capacity balancing
- The squeeze has no delay, so it leads

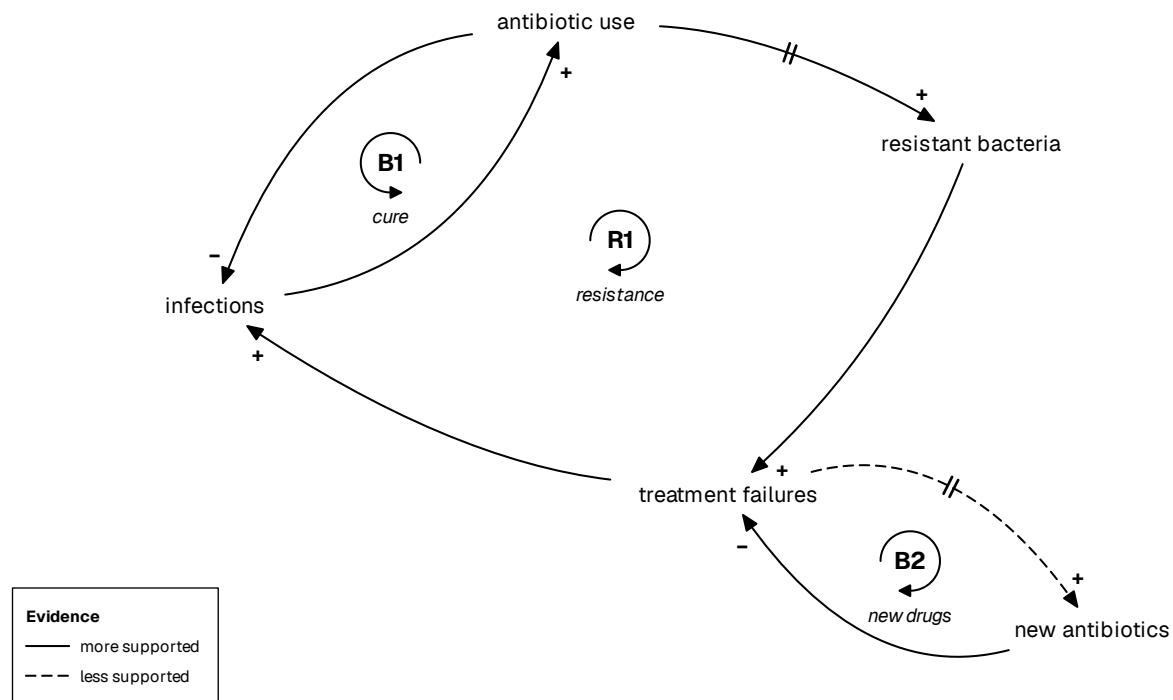
Step by step

1. The boundary, food bank, with local layoffs outside it and unmet need inside, joined by a + effect delayed by the months families' savings last.
2. Volunteer recruitment, with a + effect from unmet need: the food bank's response, which both loops pass through.
3. Training hours and regulars' shifts, with a + effect from recruitment to training hours, a – effect on to the regulars' shifts and a – effect back to unmet need: two – effects, so reinforcing, R1, training squeeze.
4. Trained volunteers, with a + effect from recruitment delayed by the weeks of training, and a – effect on unmet need: one – effect, so balancing, B1, new capacity, drawn after the squeeze it follows in time.

What another defensible answer might vary

Another answer might put the first delay on unmet need → volunteer recruitment instead, add a variable such as shifts covered between trained volunteers and unmet need, or name the boundary differently. What stays is training hours arriving before trained volunteers, so unmet need grows first: a reinforcing loop through the regulars' shifts, a balancing loop through trained volunteers, and layoffs outside the boundary with no effect running into them.

CL 07 Antibiotics and the resistance they breed



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Prescribing cures infections, and over years breeds the resistant bacteria that make them harder to cure. New antibiotics would balance the failures a decade later, if drug makers develop them.

Why it works

- Three loops share infections, antibiotic use and treatment failures
- The uncertain effect, treatment failures → new antibiotics, dashed
- Legend lists the dashed line as less supported
- Resistance and new antibiotics both arrive after a delay

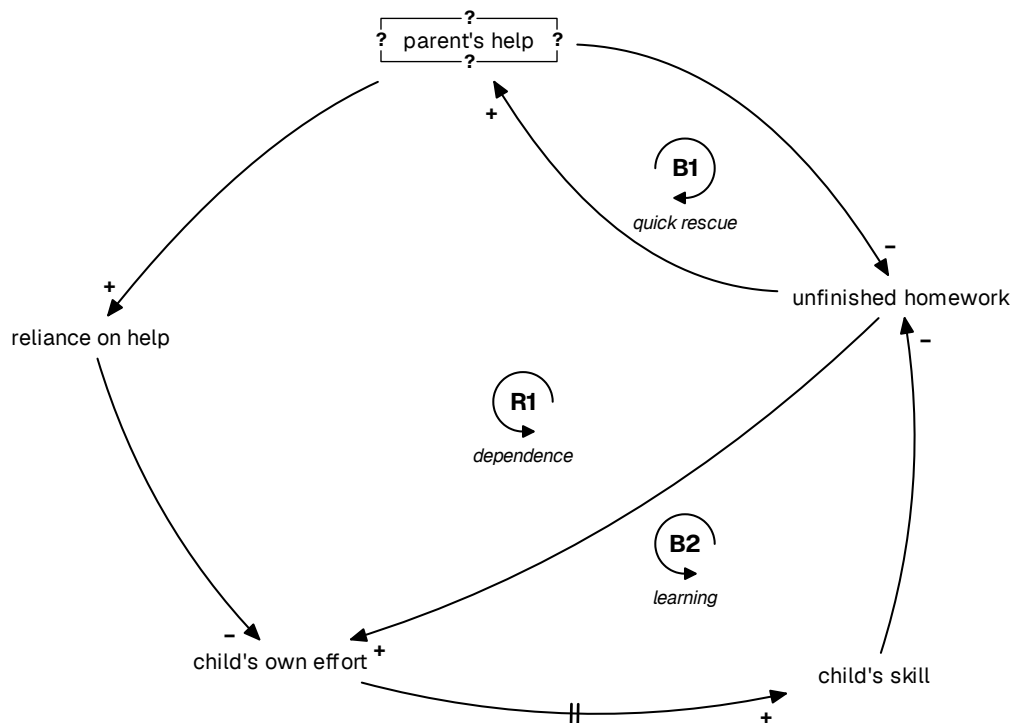
Step by step

1. Infections and antibiotic use, with a + effect from infections to use and a - effect back as cures bring infections down: balancing, B1, cure.
2. Resistant bacteria and treatment failures, with a + effect from antibiotic use delayed by years of heavy use, and + effects on to treatment failures and back to infections: no - effect, so reinforcing, R1, resistance.
3. New antibiotics, with a + effect from treatment failures delayed by a decade and dashed as a hypothesis, and a - effect back on failures: balancing, B2, new drugs, with the legend for the one dashed line.

What another defensible answer might vary

Another answer might add a stewardship loop in which treatment failures cut antibiotic use, route resistance through broader prescribing rather than through spreading infections, or code a different effect as the hypothesis.

What stays is a balancing cure loop undone by a reinforcing resistance loop, a slower balancing loop through new antibiotics, and the hypothesis dashed and declared in the legend.

CL 08 A parent who finishes the homework

This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

The parent's help clears tonight's homework at once. It also builds the child's reliance on help, which cuts the child's own effort, so skill builds slower and the next assignment gets help too.

Why it works

- Quick rescue at the top, read first
- Skill arrives after a delay
- Reliance on help cuts the child's own effort: a – effect
- Dependence is the reinforcing loop the rescue feeds

Step by step

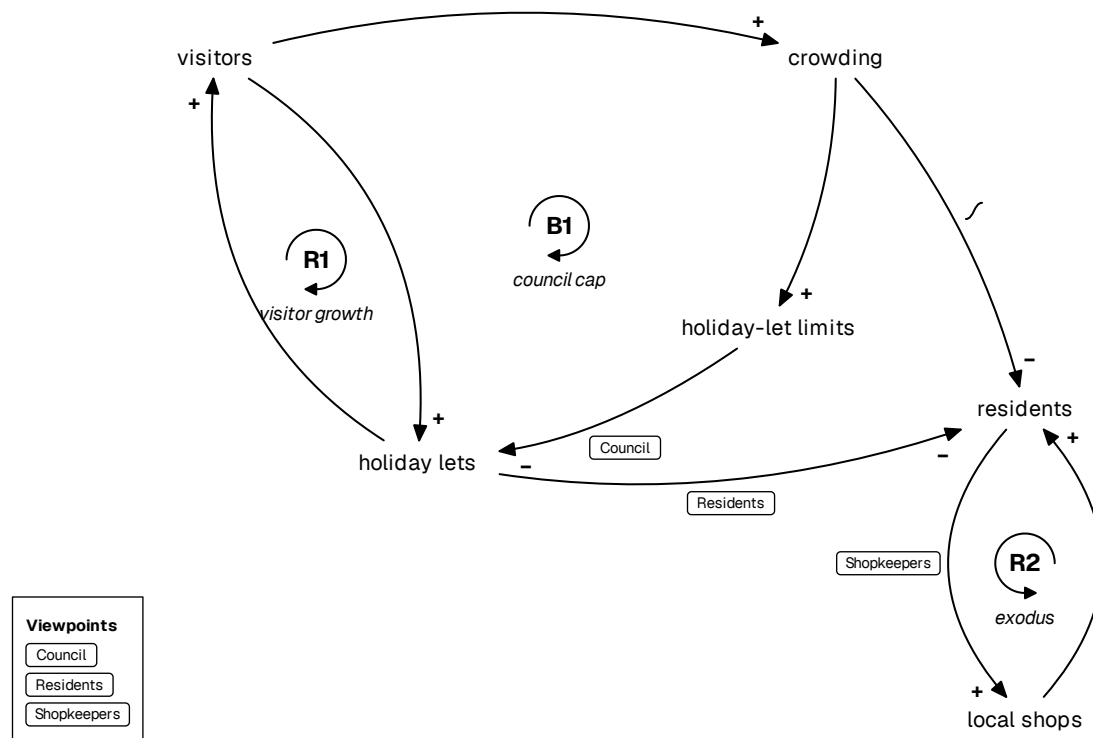
1. Unfinished homework and parent's help, marked as the leverage point, with a + effect to the help and a – effect back: balancing, B1, quick rescue, the part of the story each rushed evening starts with.
2. Child's own effort and child's skill, with a + effect from unfinished homework to effort, a + effect from effort to skill delayed by weeks, and a – effect from skill back to unfinished homework: balancing, B2, learning.
3. Reliance on help, with a + effect from parent's help and a – effect on the child's own effort, closing a loop through the rescue and the learning: two – effects, so reinforcing, R1, dependence.

What another defensible answer might vary

Another answer might run the – effect straight from parent's help to the child's own effort and leave reliance out, or make the child's own effort the leverage point instead of the parent's help. What stays is the shifting-the-

burden shape: a fast balancing rescue, a slower balancing loop through the child's skill, and a reinforcing dependence that the help feeds by crowding out the child's effort.

CL 09 An old town and its visitors



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Visitors and holiday lets feed each other, and the council's limits balance them through crowding. Past the threshold, residents leave fast, and the local shops they keep open close, so more leave.

Why it works

- Visitor growth, council cap and exodus
- Threshold marked on crowding → residents
- Council, residents and shopkeepers tagged
- Legend lists the three viewpoints

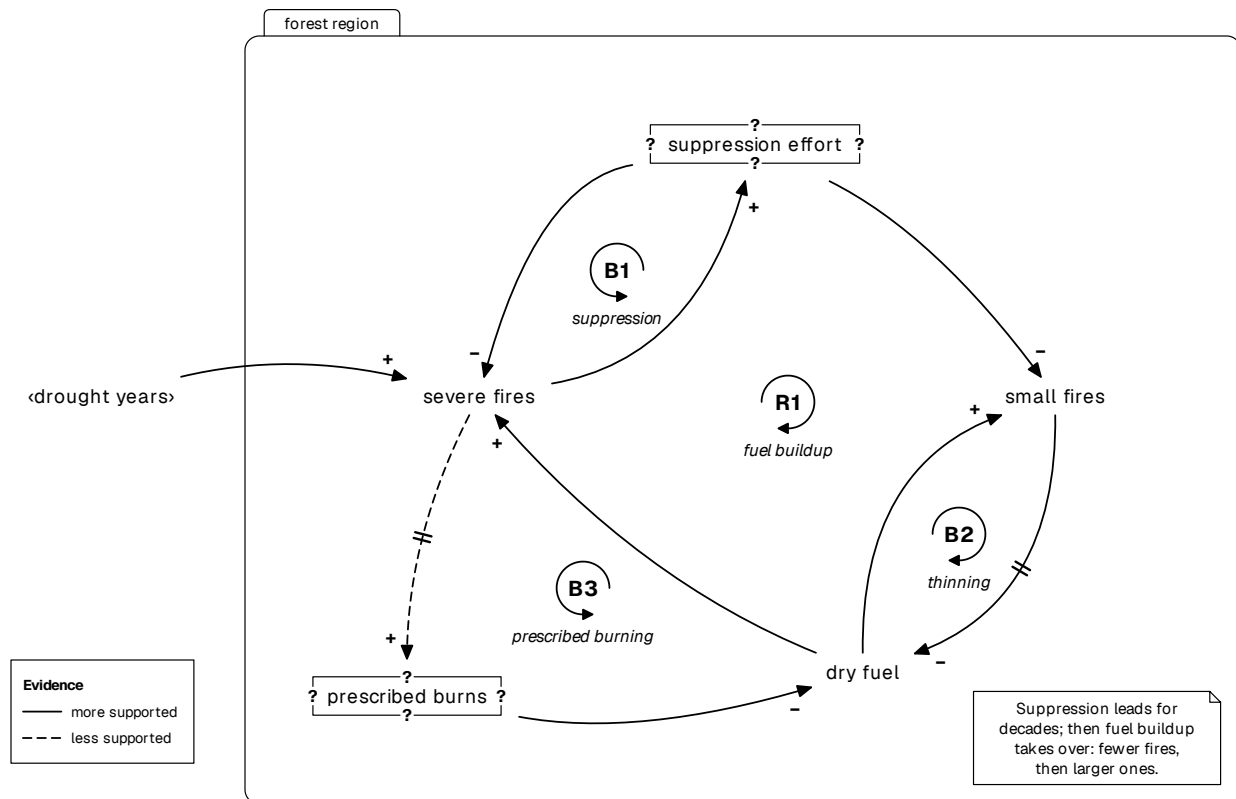
Step by step

1. Visitors and holiday lets, with a + effect each way, since visitors fill lets and lets draw visitors: reinforcing, R1, visitor growth.
2. Crowding and holiday-let limits, with + effects from visitors to crowding and on to the limits, and a – effect from the limits on holiday lets, tagged Council: one – effect, so balancing, B1, council cap, with the legend, since the Council tag is the one viewpoint drawn so far.
3. Residents, with a – effect from holiday lets, tagged Residents, and a – effect from crowding, marked nonlinear for the point where summer visitors outnumber them.
4. Local shops, with a + effect from residents, tagged Shopkeepers, and a + effect back to residents: reinforcing, R2, exodus, drawn last as the situation's third sentence has it.

What another defensible answer might vary

Another answer might put the threshold on holiday lets → residents instead, tag different effects with the three viewpoints, or add visitor spending, which keeps shops for visitors open while local shops close. What stays is two reinforcing loops, visitor growth and the exodus, a balancing loop through the council's limits, one nonlinear effect, and three viewpoints that differ in emphasis, not structure.

CL 10 A forest region and its fires



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Suppression puts out severe fires quickly, and the small fires that thin the fuel too, so fuel builds and severe fires return larger. Prescribed burns would balance the buildup after a delay, if severe fires lead to their funding.

Why it works

- Four named loops share severe fires and dry fuel
- Drought years outside the boundary, with no effect into them
- The funding effect dashed and declared in the legend
- Leverage points on suppression effort and prescribed burns
- Behavior note: suppression leads first, fuel buildup later

Step by step

1. The boundary, forest region, with dry fuel and small fires inside it, a + effect from fuel to small fires and a - effect back, delayed as the fires thin the undergrowth: balancing, B2, thinning, the forest before suppression.
2. Severe fires, with a + effect from dry fuel, and suppression effort, marked as a leverage point, with a + effect from severe fires and a - effect back on them: balancing, B1, suppression.
3. A - effect from suppression effort on small fires closes a loop back through dry fuel to severe fires: two - effects, so reinforcing, R1, fuel buildup.
4. Drought years, the external driver, outside the boundary, with a + effect on severe fires, drawn once the fires it acts on are in place.
5. Prescribed burns, marked as a leverage point, with a + effect from severe fires, delayed and dashed as a hypothesis, and a - effect on dry fuel: balancing, B3, prescribed burning, with the legend for the one dashed

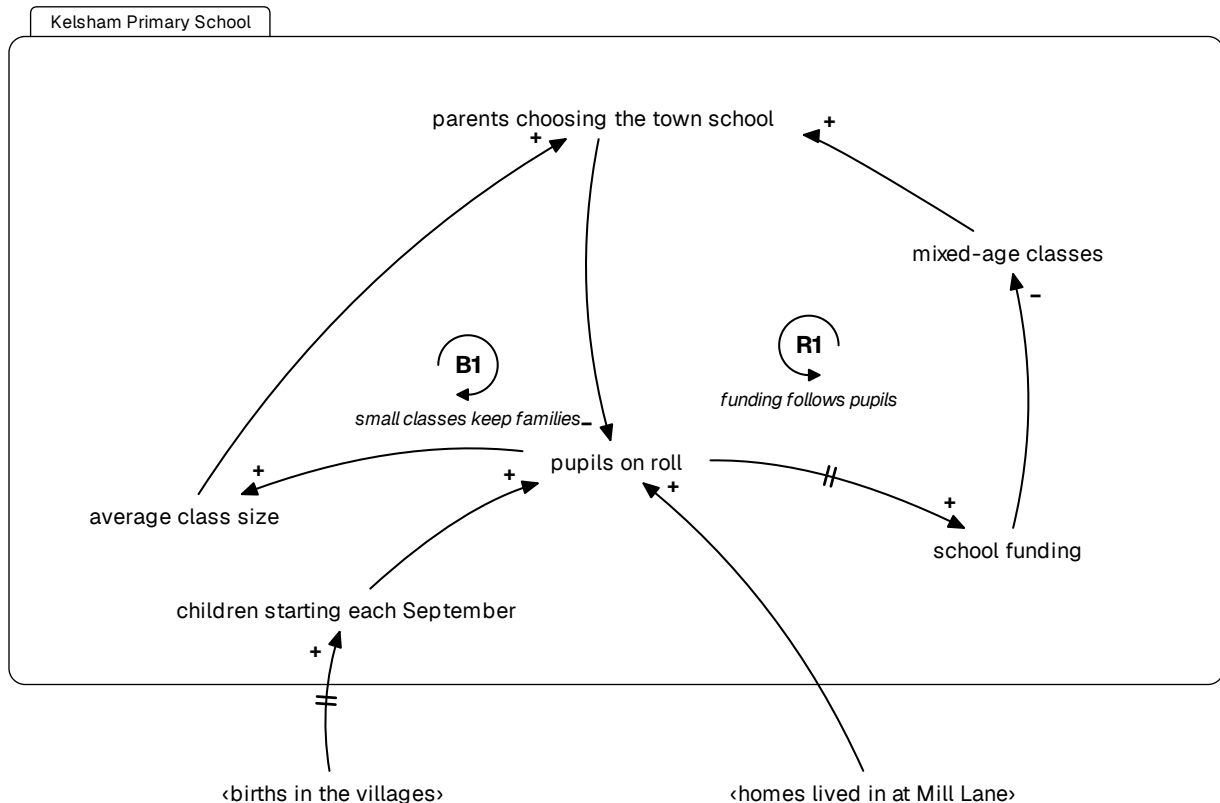
line.

6. The behavior note, once all four loops are drawn, since it is about two of them: B1 leading, R1 taking over.

What another defensible answer might vary

Another answer might add homes built in the forest, which raise suppression effort, mark dry fuel → severe fires as nonlinear past a fuel threshold, or code a different effect as the hypothesis. What stays is four named loops sharing severe fires and dry fuel, drought years outside a named boundary with no effect running into them, and the evidence coding declared in the legend.

CS 05 Kelsham Primary School: births, new homes and two loops



This is one defensible answer, not the only one. Yours can differ and still hold up: the lab's checks show whether it has the brief's structure.

Births in the villages and homes lived in at Mill Lane sit outside the boundary as external drivers: nothing the school does changes either. Births reach the starters four years later, so the fall from 22 births to 11 reaches the starters until 2029. Inside, two loops compete through the roll: R1, funding follows pupils, carries a fall in the roll further, a school year behind each October count, and B1, small classes keep families, slows it. The new homes raise the roll from 2027, and R1 then carries the rise further while B1 resists it as classes fill.

Why it works

- Births and the new homes outside the boundary, with no effect into either
- Two delays: the four years from births to starters, and the October count on the funding
- R1 has two – effects and B1 one, as the parity rule gives
- The loops share the roll, parents choosing the town school and the – effect between them, so a change in the roll runs through both
- The new homes act on the roll, not the starters: their children join every year group

Step by step

1. The boundary, Kelsham Primary School, with births in the villages outside it and children starting each September inside, joined by a + effect with a delay: a child born in the villages starts four Septembers later.
2. Pupils on roll, with + effects from the starters and from homes lived in at Mill Lane, the second external driver, whose children join every year group.
3. School funding, with a + effect from the roll and a delay: each October count sets the funding for the school year after it.

4. Mixed-age classes and parents choosing the town school, with a – effect from the funding, a + effect between them and a – effect back to the roll: two – effects, so reinforcing, R1, funding follows pupils.
5. Average class size, with + effects from the roll and on parents choosing the town school: one – effect on the way back, so balancing, B1, small classes keep families, competing with R1 for the roll.

What another defensible answer might vary

Another defensible answer might keep teachers between school funding and mixed-age classes, as CS 04 draws them, or draw parents choosing the town school on the children starting each September as well, since most families choose a school when a child starts. What stays the same is two external drivers outside a named boundary, the delay from births to starters, and a reinforcing loop through funding competing with a balancing loop through class size.