

Part V — Pattern and Judgment

Structures That Recur

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

System archetypes

Part V · Pattern and Judgment · Chapter 10 of 12 · the first of two chapters on system archetypes

Which stories play out again and again? A few loop structures recur in situations that share nothing else: a fix that brings its problem back, growth that meets a limit, a shared resource used up. A system archetype is a causal loop diagram with the name of its structure written on it, and matching reads whether its loops have that structure.

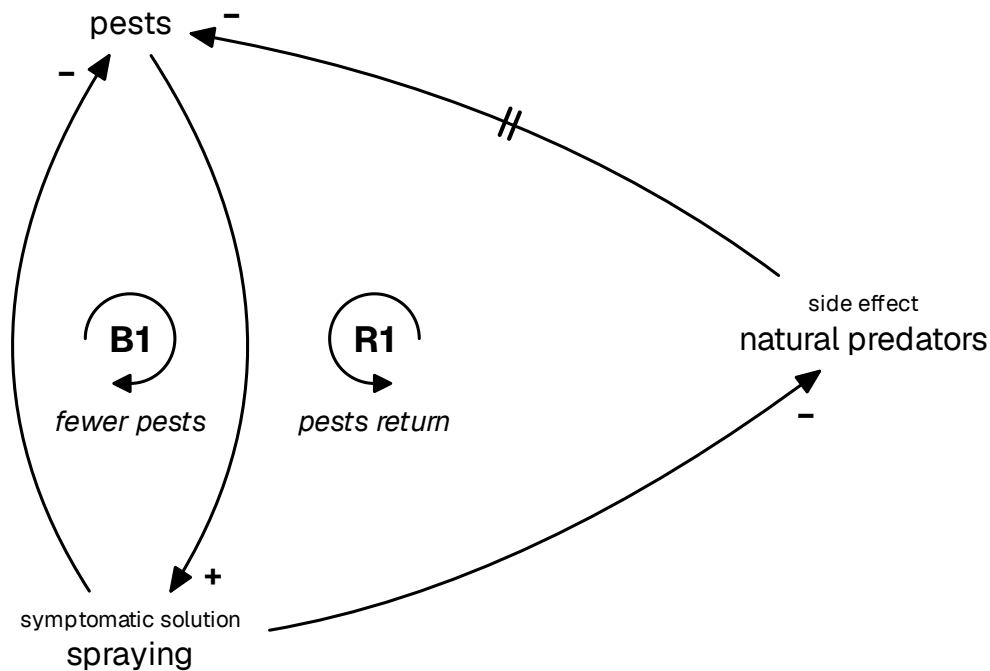
Signals you need this diagram

- A fix worked at first, and the problem came back worse.
- Growth slowed while the effort behind it kept rising.
- A fast remedy goes on being used, and a slower one is never started.
- Of two people or groups drawing on one resource, the one ahead pulls further ahead.
- Several users of one shared resource each take more, and each gets less.
- A situation's loops sound like a story from somewhere else.

Spraying a valley's rice

Farmers in a river valley spray their rice when pests build up, and within days the pests fall. The spray also kills the spiders and parasitic wasps that prey on the pests. With fewer of them, the pests come back in greater numbers over the following seasons, and the farmers spray more often. In Asia's rice fields, the International Rice Research Institute reports that early sprays kill the brown planthopper's natural enemies and make its outbreaks ten times more likely.

Archetype: fixes that fail



B1, *fewer pests*, is the spray's relief; R1, *pests return*, runs through the predators it kills. The loops match the archetype written on the diagram, *fixes that fail*, with its delay.

What the notation expresses

A **system archetype** is drawn with a causal loop diagram's marks: variables, effects with their polarities, loops thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#loops and delays. It adds two kinds of words: a variable's role, in small type above its name, and a declared archetype, one line beginning *Archetype:*.

Archetypes

An **archetype** is a named loop structure that recurs across situations. Kim opens *fixes that fail* with a squeaky wheel: water stops the squeak, the wheel rusts, and it squeaks louder. The rice valley has the same loops. Each archetype is written as a **template**: its variables, its effects with their polarities, its loops with their kinds, and where a delay belongs.

A **declared archetype** is a line of words on the diagram, *Archetype: fixes that fail*: a hypothesis that the diagram's loops hold that archetype. A diagram may carry several.

Matching

A **match** is a place in a diagram where an archetype's loops sit: each of the template's variables stood in by a different variable of the diagram, each template effect drawn as one effect or a chain of up to four, and every loop

of the template of the same kind, by the parity rule

thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#the-parity-rule. A chain holds variables the template leaves out: *pests* → *spraying* could run through *damaged leaves*.

Matching reads loops, their kinds and where delays

thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#delays sit, never what a variable is: whether *natural predators* are spiders or rain fall, or whether spraying relieves anything. So a match is a hypothesis about structure, never a verdict on the situation. A **near miss** is an archetype's loops found with one of them of the other kind, or a match without a delay the archetype has.

In the lab, the matches are listed after every change, and each declared archetype is checked against them. Finding archetypes by algorithm has a precedent in simulation models (Schoenenberger, Schmid and Schwaninger, 2015).

Symptomatic and fundamental solutions

A **symptomatic solution** relieves a symptom quickly: *spraying*, with *symptomatic solution* written above its name. A **fundamental solution** acts on the cause, more slowly, and is written *fundamental solution*. The rice valley has none drawn. One drawn in reply to the pests, lowering them after a delay and weakened as the predators fall, would make it a shifting the burden.

Which remedy is which depends on who is asked: Kim writes that there may be no agreement on whether a remedy is symptomatic or fundamental. A role is written by whoever draws the diagram, and checked only for fitting a match: its variable must stand where the archetype puts that role.

CHECK YOUR UNDERSTANDING

Rain comes through a cracked roof tile into an attic. Whenever it rains, someone sets out pans and empties them, and the attic floor stays dry. Replacing the tile would take a roofer and a dry week, and the longer the pans keep the floor dry, the less anyone thinks of calling one. In a system archetype of the attic, which variable is the symptomatic solution?

- a water on the attic floor
- b pans emptied
- c tiles replaced
- d how used to the leak the household is

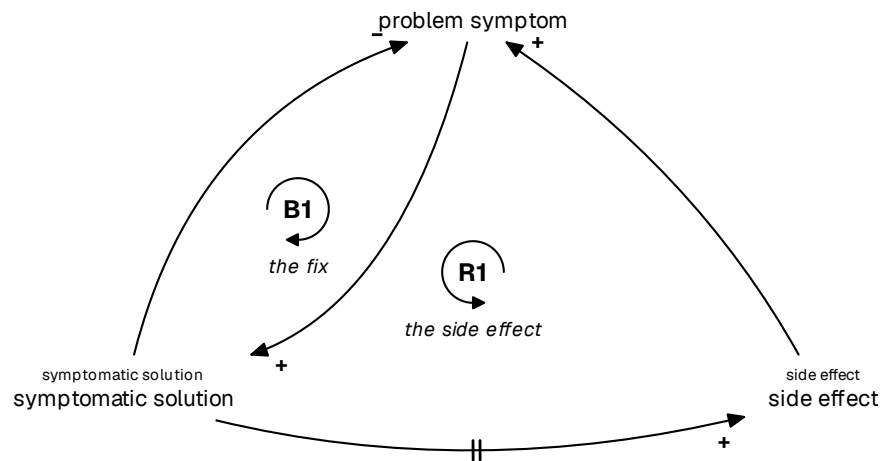
Feedback: Answers, chapter 10

Side effects

A **side effect** is a consequence of the symptomatic solution, usually delayed: *natural predators*, which spraying lowers, with *side effect* written above the name. In fixes that fail it worsens the problem symptom; in shifting the burden it weakens the fundamental solution. The role goes on the consequence, not on the symptom it brings back.

Fixes that fail

Archetype: fixes that fail



The fix loop (B1) relieves the problem symptom; the side effect's loop (R1) brings it back, after a delay on one of the effects through the side effect. Which of the two drives behavior when is loop dominance thinking-in-diagrams.aryehnielsen.com/feedback/delays-drivers-and-competing-loops/#loop-dominance: the fix first, the side effect after its delay.

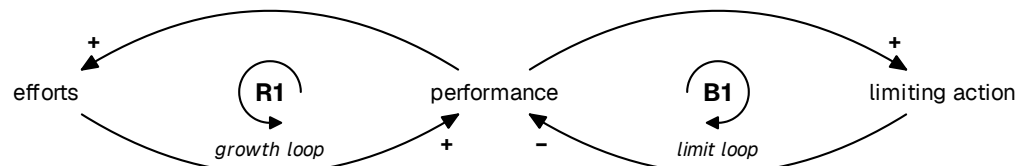
The answers to chapter 4's CL 05

thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#exercise-causal-loop-05, borrowing to get to the end of the month, and chapter 5's CL 07

thinking-in-diagrams.aryehnielsen.com/feedback/delays-drivers-and-competing-loops/#exercise-causal-loop-07, antibiotics, match fixes that fail with its delay.

Limits to growth

Archetype: limits to growth



A reinforcing loop, the **growth loop**, and a balancing loop, the **limit loop**, share *performance*: efforts raise performance and performance spurs efforts, until the limiting action holds performance back. Kim calls limits to growth *limits to success*, and puts the leverage in removing what limits growth, not in pushing harder on the growth loop: a leverage point

thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#leverage-points on the limiting action.

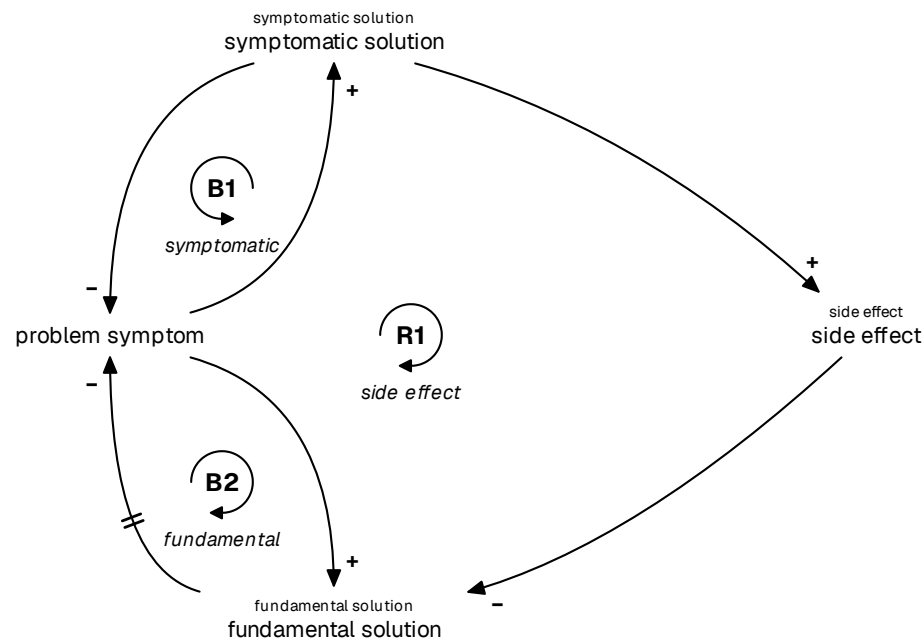
What sets the limit, the **constraint**, acts from outside both loops, so the template leaves it out.

The answer to chapter 5's CL 09

thinking-in-diagrams.aryehnielsen.com/feedback/delays-drivers-and-competing-loops/#exercise-causal-loop-09, an old town and its visitors, matches no limits to growth: its two loops share an effect, *holiday lets* → *visitors*, where limits to growth's share one *variable*.

Shifting the burden

Archetype: shifting the burden



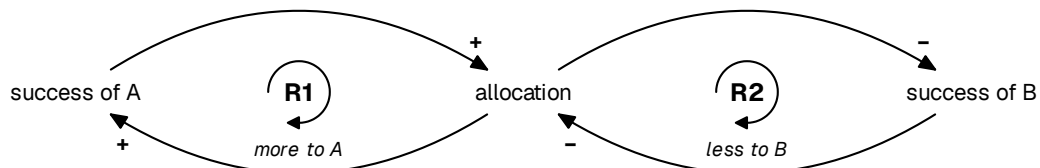
Two balancing loops relieve one problem symptom: the symptomatic solution's at once, the fundamental solution's after a delay. The symptomatic solution's side effect weakens the fundamental solution, closing a reinforcing loop through both. Its symptomatic loop and reinforcing loop together match fixes that fail, the side effect's way back to the problem symptom running through the fundamental solution. Where that way is a chain of four effects or fewer, as in the figure, every shifting the burden holds one.

The answer to chapter 5's CL 08

thinking-in-diagrams.aryehnielsen.com/feedback/delays-drivers-and-competing-loops/#exercise-causal-loop-08, a parent who finishes the homework, matches shifting the burden with its delay.

Success to the successful

Archetype: success to the successful

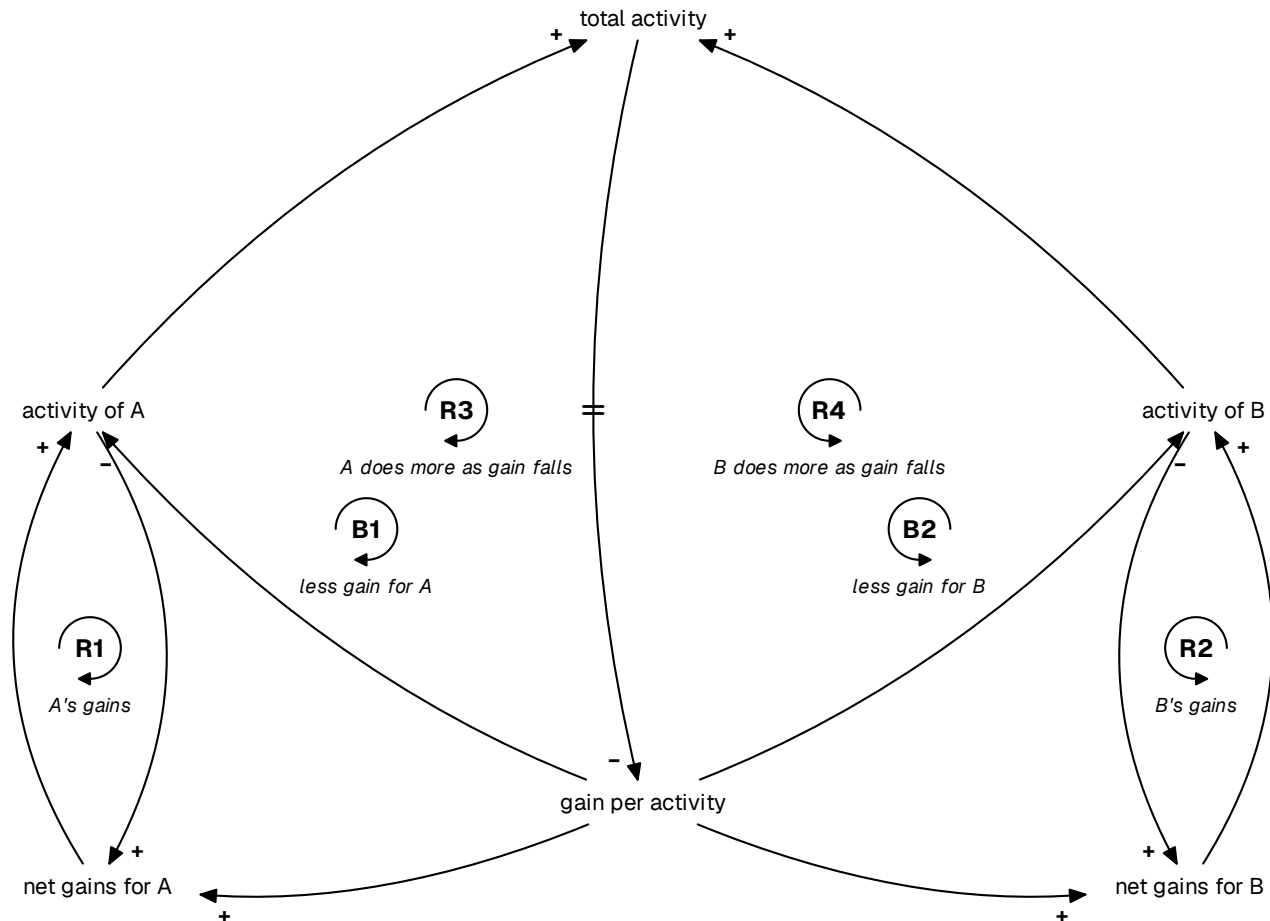


Two reinforcing loops share one allocation between A and B: success of A wins A a larger share, and a larger share to A is less to B, whose success falls and wins it less again. Which side ends ahead depends on where each started, as much as on what each could do with an equal share (Kim).

Any two reinforcing loops sharing one variable match it, whatever their polarities: *success of B* named as *failure of B* turns its two – into +.

Tragedy of the commons

Archetype: tragedy of the commons



Each user's activity raises their net gains, which raise their activity (R1, R2). All activity adds to total activity, which, after a delay, lowers the gain per activity of every user (B1, B2). A lower gain per activity raises each user's activity, closing two more reinforcing loops through total activity (R3, R4), which Kim draws and leaves unnamed. The resource limit sits outside the loops. Where the shared resource accumulates, as the fish on AR 05's fishing ground do, it is a stock thinking-in-diagrams.aryehnielsen.com/accumulation/what-accumulates/#stocks. Three users give three matches, one for each pair. Kim puts the remedy above the level of any one user.

A variable named as its opposite

In the rice valley, *natural predators* fall as spraying rises, and their fall raises the pests: two – effects where the template's side effect has two +. Named *predators lost*, the same variable would carry two +.

A variable named as its opposite changes the polarity of every effect into and out of it. A loop through it passes two of those, so the parity rule

thinking-in-diagrams.aryehnielsen.com/feedback/loops-that-amplify-loops-that-correct/#the-parity-rule gives it the same kind, and the match holds, with the variable reported as named as its opposite.

CHECK YOUR UNDERSTANDING

A gym fills up every January: each new member brings friends along, and the friends join. By February the crowded floor puts members off. Someone draws it with space on the gym floor where crowding would go: members → space on the gym floor –, space on the gym floor → members +, beside members → friends brought along → members, both +. Does it match limits to growth?

- a** Yes, with space on the gym floor named as its opposite
- b** No: the archetype has performance → limiting action +, and this effect is –
- c** No: with space where crowding would go, the loop through it is reinforcing

Feedback: Answers, chapter 10

What stays informal

What a variable is: matching reads structure, so whether the valley's story is a fix that fails, whether these predators eat these pests, is a question for evidence about the valley.

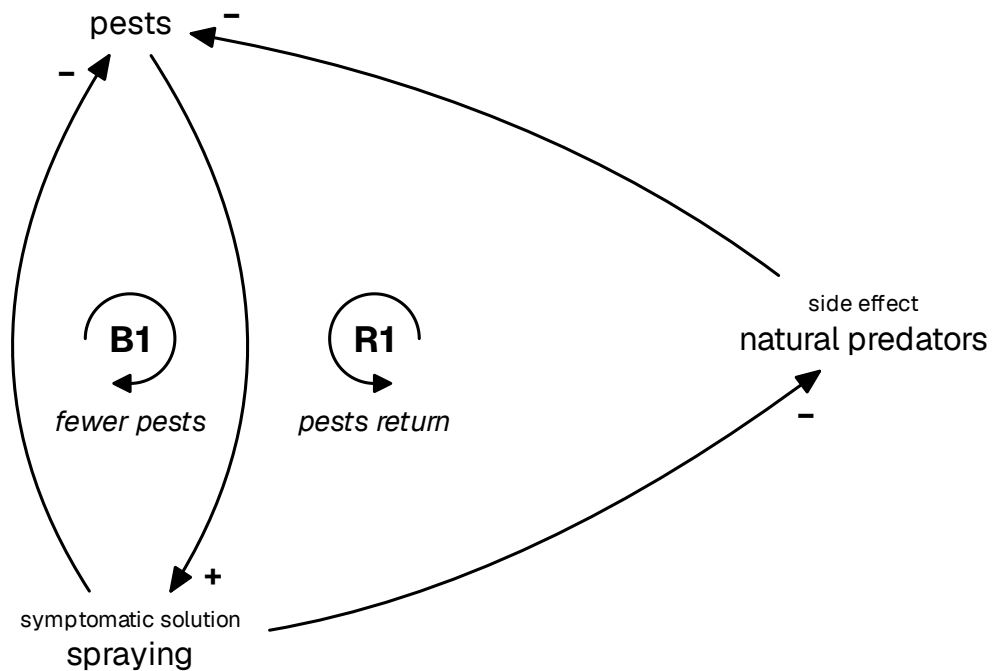
Timing beyond where delays sit: a delay shows that a change arrives late, not whether a season or a decade late. That goes in a behavior note or a sentence.

Leverage beyond the leverage point's box: the box marks a hypothesis about where to act; why there, and how hard to push, go in prose beside the diagram.

The bad diagram

What's wrong with this diagram of the rice valley?

Archetype: fixes that fail



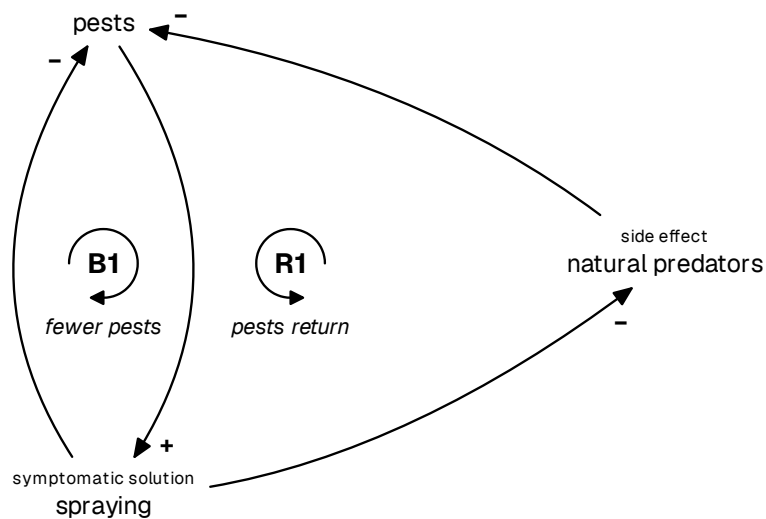
Its variables, polarities, loops and declaration are the corrected diagram's, and its loops match fixes that fail. But *natural predators* → *pests* carries no delay, as if the pests came back the *day* the spray killed their predators. The lab's check reports:

Matches fixes that fail without its delay: the side effect comes late, and no effect on spraying → natural predators → pests has a delay. Brief: fixes that fail, with its delay.

The corrected diagram

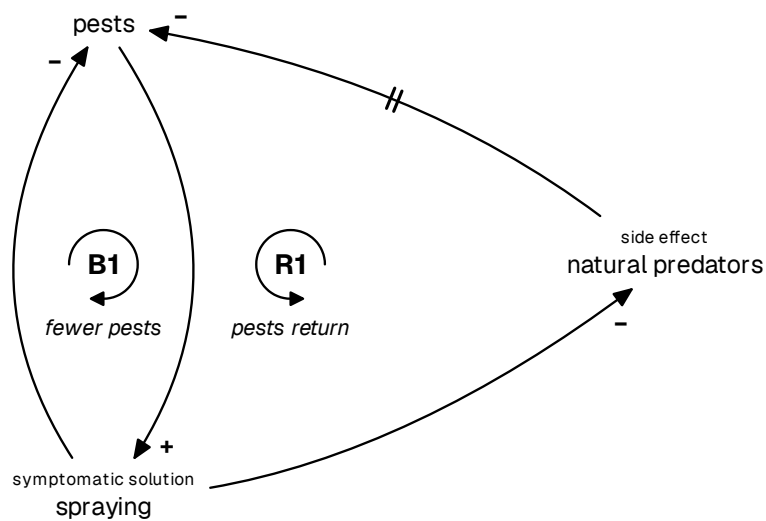
Corrected, *natural predators* → *pests* carries a delay: the pests come back over seasons, after weeks of relief.

Archetype: fixes that fail



Corrected diagram

Archetype: fixes that fail



Labels unchanged. Effects: 1 delay added. Now matched with its delay: fixes that fail.

Notation moves

Notation move	When	What it shows	Example
Declare an archetype	The loops have a structure that recurs across situations	A hypothesis about the loops, checked against the matches	<i>Archetype: fixes that fail</i>
Archetype: fixes that fail			
Write <i>symptomatic solution</i> above a variable	It relieves a symptom quickly	The fast remedy	<i>spraying</i>
symptomatic solution spraying			
Write <i>fundamental solution</i> above a variable	It acts on the cause, more slowly	The slow remedy the side effect weakens	<i>tiles replaced, under a leaking roof</i>
fundamental solution tiles replaced			
Write <i>side effect</i> above a variable	A consequence of the symptomatic solution comes back	Where the later loop leaves the fix	<i>natural predators</i>
side effect natural predators			
Mark the archetype's delay		Which change comes late	<i>natural predators → pests</i>
side effect natural predators			

Notation move	When	What it shows	Example
Name a variable as its opposite	Its name reads better the other way round	The same match	<i>natural predators</i> for <i>predators lost</i>
Propose a leverage point on the limiting action	Growth meets a limit	Where Kim puts the leverage	<i>crowding</i> , in a gym that fills every January

Check your understanding

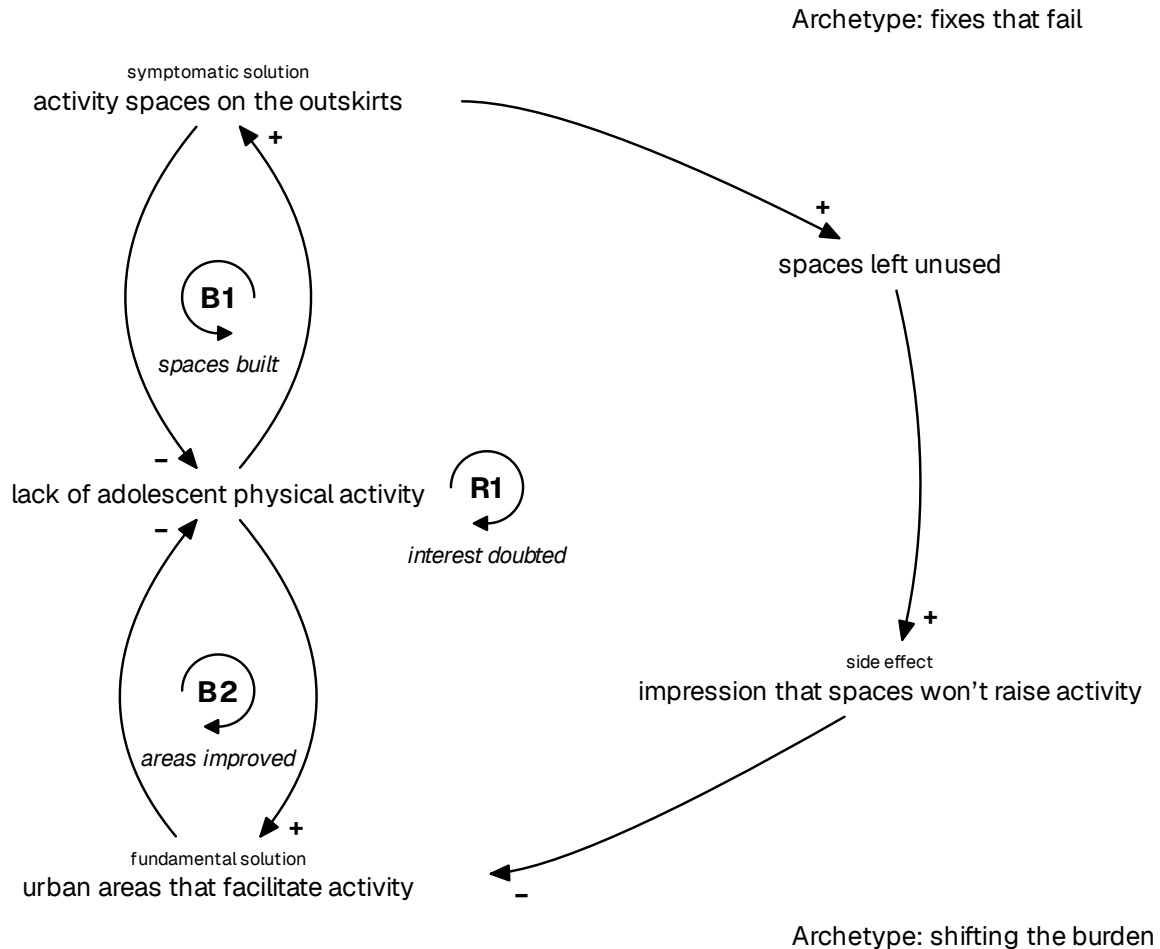
CHECK YOUR UNDERSTANDING

Evening pick-up games on a park's basketball court: players bring friends, and the friends come back the next week. As the court fills, players wait longer between games, and some stop coming. A diagram of the court, with players, friends brought along and waiting time, matches limits to growth. What does the match show?

- a** That the diagram's loops have the structure of limits to growth
- b** That players stop coming because of the waiting
- c** That a second court is where to act

Feedback: Answers, chapter 10

Activity spaces on Amsterdam's outskirts, redrawn



Redrawn from Jillian O'Mara, Loes Crielaard, Luc Hagenaaars, Karien Stronks and Wilma Waterlander, "Using systems archetypes to understand system behaviour and identify leverage points for change in local obesity prevention in The Netherlands", Health Promotion International 41(3), daag056 (2026) doi.org/10.1093/heapro/daag056, Table 1, LA2, its causal loop diagram. CC BY 4.0 creativecommons.org/licenses/by/4.0/.

Its prefixes Symptomatic solution, Fundamental solution and Side-effect written as roles above the names, and Problem symptom dropped; its dashed lines, its mark for an inverse effect, drawn solid with a -, since a dash here marks a hypothesis; its color left out; spaces aren't used renamed as an amount, spaces left unused, and the other four names shortened; each loop named; fixes that fail and shifting the burden, the two archetypes its authors name, declared.

QUESTION 1 OF 3

Its authors name two archetypes, and both are declared. Which loops hold fixes that fail?

- a B1 and B2, the two balancing loops sharing the lack of adolescent physical activity.
- b B1, spaces built, and R1, interest doubted.
- c B2, areas improved, and R1, interest doubted.

QUESTION 2 OF 3

More impression that spaces won't raise activity: what does it change, and through which loop?

- a More activity spaces on the outskirts, through its own effect on them.
- b Nothing in the loops: a side effect sits outside them.
- c Fewer urban areas that facilitate activity, so the lack of activity stays high: R1.

QUESTION 3 OF 3

The figure has no delay, as its authors drew none. On which effect does shifting the burden's delay belong?

- a Urban areas that facilitate activity → lack of adolescent physical activity.
- b Activity spaces on the outskirts → lack of adolescent physical activity.
- c Spaces left unused → impression that spaces won't raise activity.

Feedback: Answers, chapter 10

Exercises

Passing the checks means meeting the brief, not being right.

AR 01 Watering a lawn a little every evening

Your palette

customers

variable

price → sales

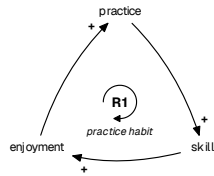
effect

price → sales → revenue
- +

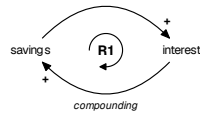
polarity

orders → deliveries
+ +

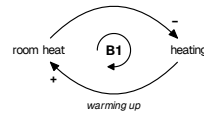
delay



loop



reinforcing loop



balancing loop

oscillation

behavior note

Archetype: fixes that fail

archetype

pests → symptomatic solution
spraying

symptomatic solution
a role, written above its
variable's name

spraying → side effect
predators lost

side effect
a role, written above its
variable's name

AR 01 Watering a lawn a little every evening

A relief that brings the problem back

Reasoning ●○○○○ 1 of 5 Polish ●○○○○ 1 of 5

Every summer evening, Rosa waters her lawn for ten minutes wherever it has turned brown, and by morning the grass is green again: the browner the lawn, the more she waters. Ten minutes wets only the top few centimeters of soil, so over the following weeks the grass keeps its roots there, where the soil dries first: the more evening watering, the faster the grass dries in heat. The faster the grass dries, the browner the lawn in each hot spell.

The brief

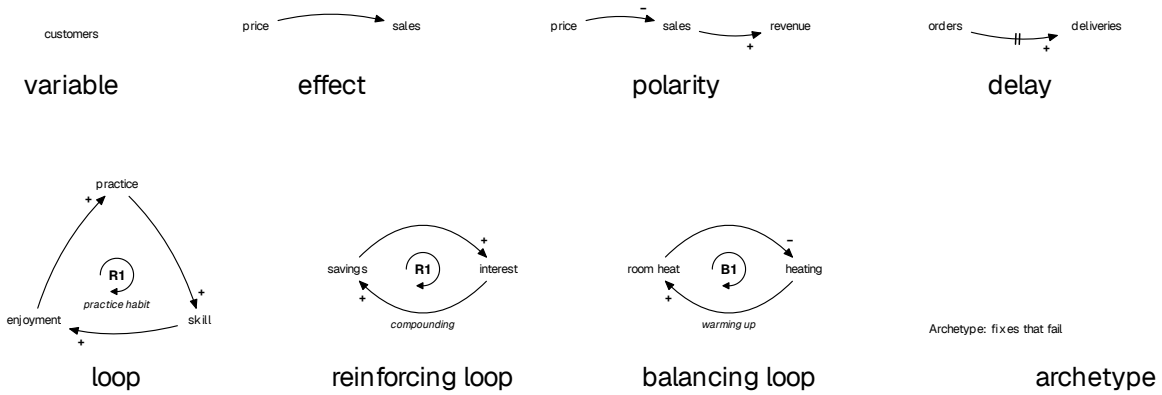
- ☐ Draw the morning's relief as one balancing loop through the brown lawn and the evening watering.
- ☐ Draw the drying grass's return to the brown lawn as one reinforcing loop.
- ☐ Mark one delay: the weeks before the watering makes the grass dry faster.
- ☐ The two loops match fixes that fail, with its delay on the side effect's chain.
- ☐ Write the symptomatic solution above the evening watering.
- ☐ Write the side effect above how fast the grass dries.
- ☐ Add a behavior note.
- ☐ The note names the relief each morning and the browning that comes back faster.
- ☐ The brown lawn is drawn once, as the variable the watering relieves and the drying grass makes worse.

Your palette

On the page before this sheet.

Draw here

Diagram drawing area with a grid of dots.

AR 02 Electric cars and public chargers**Your palette**

AR 02 Electric cars and public chargers

Growth held back by what it uses

Reasoning ●○○○○ 1 of 5 Polish ●●○○○ 2 of 5

In a country of five million people, electric cars are cheap to run, and their owners tell friends, family and colleagues so: the more electric cars on the road, the more owners' recommendations, and the more recommendations, the more electric cars people buy. Owners without a driveway charge at public chargers, so the more electric cars on the road, the longer the queues at public chargers, and the more public chargers, the shorter the queues. Word of hour-long waits takes months to reach people choosing their next car; then the longer the queues, the fewer electric cars join the road.

The brief

- ☐ Draw the recommendations as one reinforcing loop through the electric cars on the road.
- ☐ Draw the queues holding back new electric cars as one balancing loop.
- ☐ The two loops match limits to growth: a reinforcing loop and a balancing loop sharing one variable.
- ☐ Mark the months before word of the queues reaches buyers as a delay inside the balancing loop.
- ☐ The number of public chargers is the constraint: a variable outside both loops, with an effect into the balancing loop.

Your palette

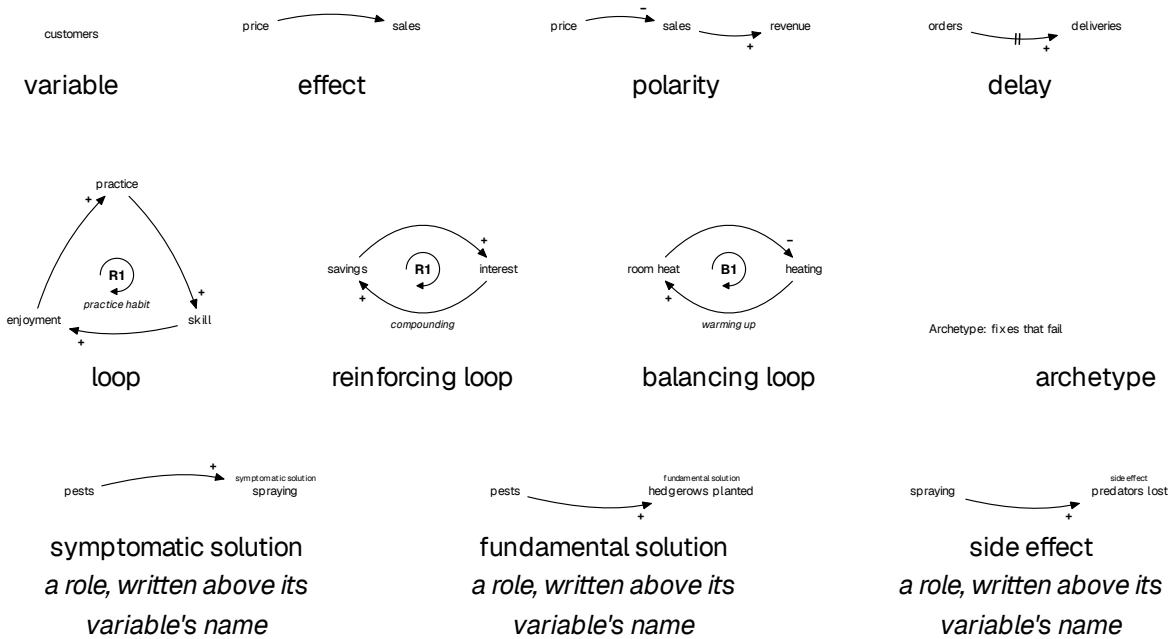
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Draw here

Diagram drawing area with a grid of dots.

AR 03 A climbing club that hires guides for its trips

Your palette

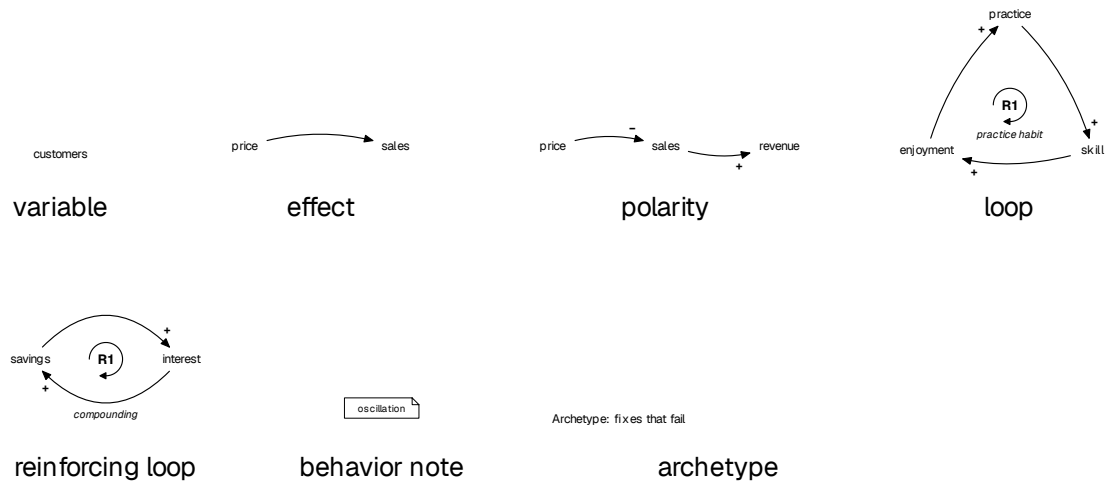


A quick relief that holds back a slower one

A climbing club of sixty members runs two trips a month, and each trip needs one qualified leader for every six climbers. When a trip is short of a leader, the club hires a mountain guide for the weekend and the trip goes ahead: the more trips short of a leader, the more hired guides, and the more hired guides, the fewer trips short of a leader. Members can qualify to lead trips themselves through courses and logged climbs that take a full season: the more trips short of a leader, the more members training to lead, and a season later, the more members training, the fewer trips short of a leader. Each guided trip shows the members that a guide will be hired: the more hired guides, the more the club relies on them, and the more it relies on them, the fewer members train to lead.

- ☐ Draw two balancing loops through the trips short of a leader: one through the hired guides, one through the members training to lead.
- ☐ Draw the reliance on hired guides closing one reinforcing loop.
- ☐ The loops match shifting the burden, with its delay on the training's loop.
- ☐ Write the symptomatic solution above the hired guides.
- ☐ Write the fundamental solution above the members training to lead.
- ☐ Write the side effect above the reliance on hired guides.
- ☐ The side effect is the reliance the hired guides build up, not a second shortage of leaders.

On the page before this sheet.

AR 04 Two parks and one maintenance budget**Your palette**

AR 04 Two parks and one maintenance budget

A small lead that a split widens

Reasoning ●●○○○ 2 of 5 Polish ●●●○○ 3 of 5

A town of thirty thousand people has two parks, one by the river and one on the hill, and one maintenance budget for both. Each spring the council splits the budget by the two parks' visitor counts from the year before, and the larger a park's share, the better it is mowed, cleaned and repaired that year. The more visitors to the riverside park, the larger the share of the budget to the riverside park, and the larger that share, the more visitors to the riverside park. The more visitors to the hilltop park, the smaller the riverside park's share, and the larger the riverside park's share, the fewer visitors to the hilltop park. In the first year, the riverside park had a few hundred more visitors than the hilltop park.

The brief

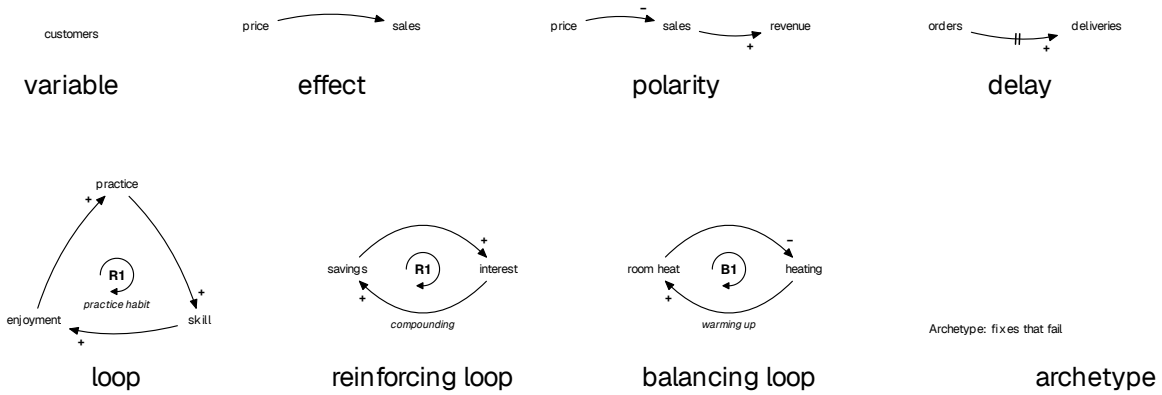
- ☐ Draw the share of the budget to the riverside park as one variable, with two reinforcing loops through it: one through each park's visitors.
- ☐ The two loops match success to the successful: two reinforcing loops sharing one variable.
- ☐ Add a behavior note on the gap between the two parks' visitors.
- ☐ The two loops are drawn as mirror images, one on each side of the share.
- ☐ In the note: the first year's gap is small, and the split widens it every year after.

Your palette

On the page before this sheet.

Draw here

Diagram drawing area with a grid of dots.

AR 05 Three countries' fleets on one fishing ground**Your palette**

AR 05 Three countries' fleets on one fishing ground

Gains kept by each, losses shared by all

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

Three countries, called here the northern, western and eastern, send fishing fleets to one fishing ground in international waters. Each fleet's owners spend what they earn on more boats: the more northern boats, the more northern earnings, and the more northern earnings, the more northern boats, and the same holds for the western and eastern fleets. Every boat adds to the total catch, and the larger the total catch, the fewer fish are left to breed. The young fish that go unborn would have been caught years later, so only then does the catch per boat fall: the larger the total catch, the smaller the catch per boat, after a delay of years. The larger the catch per boat, the more each fleet earns; and the smaller the catch per boat, the more boats each fleet sends to make up its catch.

The brief

- ☐ Draw each fleet's boats and earnings as a reinforcing loop, and its boats, the total catch and the catch per boat as another: two for each of the three fleets.
- ☐ Draw each fleet's boats returning to its earnings through the total catch and the catch per boat as a balancing loop, one for each fleet.
- ☐ The loops match tragedy of the commons, with its delay on the total catch's effect on the catch per boat.
- ☐ The total catch is one variable, which all three fleets' boats add to, not one for each fleet.
- ☐ No effect crosses another where moving a variable would avoid it.

Your palette

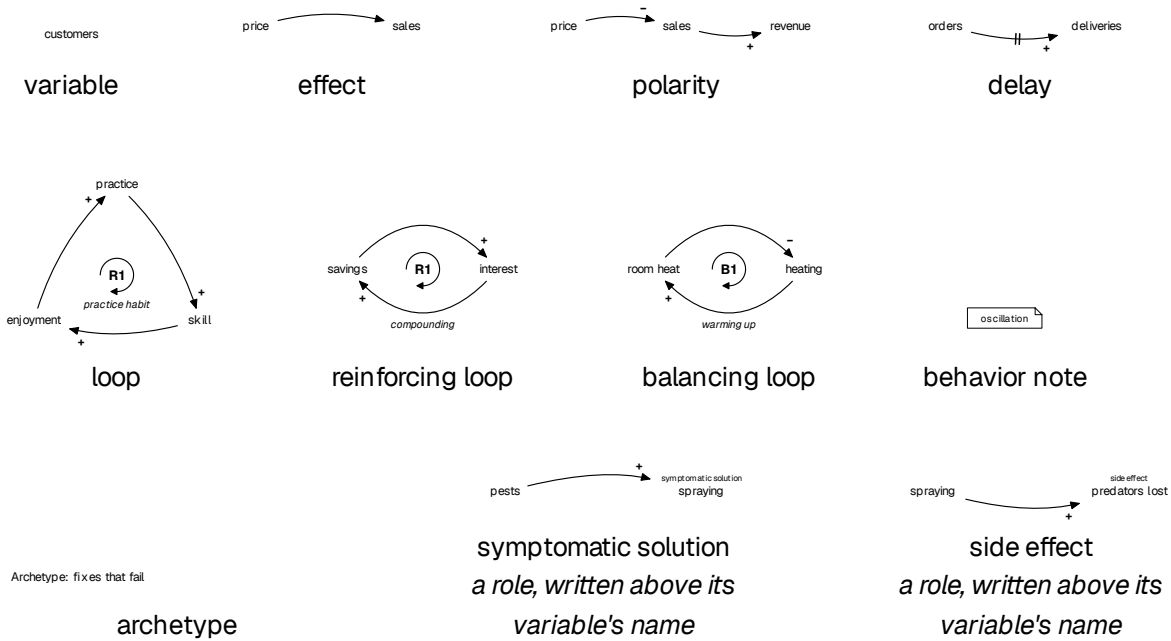
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Diagram drawing area with a grid of dots.

CS 10 Kelsham Primary School: merging classes to balance the budget

Your palette



CS 10 Kelsham Primary School: merging classes to balance the budget

A saving that brings the spending back

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

Kelsham Primary School is paid £4,800 for each pupil, set from the October count before each school year, so its funding falls a year after its roll does: the fewer pupils on roll, the less school funding, a year later, and the less school funding, the more spending above funding. When the school spends more than its funding, the governors merge classes. In 2023, with 108 pupils, they taught Years 3 and 4 as one class and paid four teachers instead of five, saving £52,000 a year at once: the more spending above funding, the more mixed-age classes, and the more mixed-age classes, the less spending above funding. Some parents, Priya Shah among them, would rather each year were taught as a class of its own, as at Brayford Primary School: the more mixed-age classes, the more parents choosing the town school, and the more parents choosing the town school, the fewer pupils on roll. In October 2026 the roll is 88, and Tom Hale, who chairs the governors, proposes teaching Reception with Years 1 and 2.

The brief

- ☐ Draw the saving as one balancing loop through spending above funding and mixed-age classes.
- ☐ Draw the families' leaving as one reinforcing loop back to spending above funding.
- ☐ Mark one delay: the October count, which sets the funding a year after pupils leave.
- ☐ The two loops match fixes that fail, with its delay on the side effect's chain.
- ☐ Write the symptomatic solution above its variable.
- ☐ Write the side effect above its variable.
- ☐ Declare the archetype the loops match, in one line.
- ☐ Add a behavior note.
- ☐ The note names the saving each merger brings at once and the spending that comes back as the roll falls.

Your palette

On the page before this sheet.

Draw here

Grid area for drawing.

Sources

- Daniel H. Kim, *Systems Archetypes I: Diagnosing Systemic Issues and Designing High-Leverage Interventions* thesystemsthinker.com/wp-content/uploads/2016/03/Systems-Archetypes-I-TRSA01_pk.pdf (Pegasus Communications, 1992, 2000): the archetypes used as templates, p. 2; Peter Senge's *The Fifth Discipline* (1990) as the source of the term, p. 3; fixes that fail and the squeaky wheel, pp. 16–17; Kim's name for limits to growth and where its leverage lies, pp. 20–21; shifting the burden, and disagreement over which remedy is symptomatic, pp. 22–23; success to the successful and its starting conditions, pp. 24–25; the tragedy of the commons and why its remedy lies above any one user, pp. 26–27.
- Lukas Schoenenberger, Alexander Schmid and Markus Schwaninger, “Towards the Algorithmic Detection of Archetypal Structures in System Dynamics” doi.org/10.1002/sdr.1526, *System Dynamics Review* 31, no. 1–2 (2015): 66–85, on algorithms that find archetypes in simulation models.
- International Rice Research Institute, “Letting Nature Manage Its Battles” ricetoday.irri.org/letting-nature-manage-its-battles/, *Rice Today* (6 October 2012), on early sprays that kill the brown planthopper's natural enemies and make its outbreaks ten times more likely.

Answers

Chapter 10 · Structures That Recur

Rain comes through a cracked roof tile into an attic. Whenever it rains, someone sets out pans and empties them, and the attic floor stays dry. Replacing the tile would take a roofer and a dry week, and the longer the pans keep the floor dry, the less anyone thinks of calling one. In a system archetype of the attic, which variable is the symptomatic solution?

- a water on the attic floor

Not quite. That is the problem symptom: the quantity the pans and the new tile both lower.

- b pans emptied

Yes. The pans lower the water on the floor within the hour and leave the crack as it was, so they relieve the symptom quickly: the symptomatic solution.

- c tiles replaced

Not quite. Replacing the tile acts on the cause, more slowly, after a roofer and a dry week: the fundamental solution, with the delay on its effect.

- d how used to the leak the household is

Not quite. That is the side effect: the pans raise it, and it lowers the tiles replaced, closing a reinforcing loop through both remedies, as shifting the burden has it.

A gym fills up every January: each new member brings friends along, and the friends join. By February the crowded floor puts members off. Someone draws it with space on the gym floor where crowding would go: members → space on the gym floor –, space on the gym floor → members +, beside members → friends brought along → members, both +. Does it match limits to growth?

- a Yes, with space on the gym floor named as its opposite

Yes. Members and friends brought along close a reinforcing loop. Members and space on the gym floor close a loop with one –, so it is balancing. The limiting action rises with performance; space falls as members rise, so it stands as the limiting action named as its opposite.

- b No: the archetype has performance → limiting action +, and this effect is –

Not quite. Matching reads loop kinds, not each effect's polarity. Naming crowding as space on the gym floor changes the polarity of both effects on the loop through it, so the loop keeps one – and stays balancing.

- c No: with space where crowding would go, the loop through it is reinforcing

Not quite. Count the – effects: members → space on the gym floor is the only one. One is odd, so the loop is balancing, as limits to growth has it.

Evening pick-up games on a park's basketball court: players bring friends, and the friends come back the next week. As the court fills, players wait longer between games, and some stop coming. A diagram of the court, with players, friends brought along and waiting time, matches limits to growth. What does the match show?

- a That the diagram's loops have the structure of limits to growth
Yes. Matching reads loops, their kinds and where delays sit: here a reinforcing loop and a balancing loop sharing players. Whether waiting time is what keeps players away is a question about the court, not about the drawing.
- b That players stop coming because of the waiting
Not quite. That is the story the diagram was drawn from. If players stop coming because the evenings grow dark, the same loops are in the diagram, and they still match; the story is what would be wrong.
- c That a second court is where to act
Not quite. Kim puts the leverage in limits to growth at the limit, and a second court acts there. But that is a leverage point, a hypothesis drawn in its own box; a match places no leverage point.

QUESTION 1 OF 3

Its authors name two archetypes, and both are declared. Which loops hold fixes that fail?

- a B1 and B2, the two balancing loops sharing the lack of adolescent physical activity.
Not quite. Two balancing loops sharing one variable have the shape of escalation and eroding goals, and both match here, within shifting the burden. Fixes that fail has a reinforcing loop, and R1 is the only one.
- b B1, spaces built, and R1, interest doubted.
Yes. B1 is the fix, through activity spaces on the outskirts; R1 leaves the same spaces through the side effect and comes back to the problem symptom through urban areas that facilitate activity. That way back is a chain of two effects, so fixes that fail sits within shifting the burden, as it does wherever the way back is four effects or fewer.
- c B2, areas improved, and R1, interest doubted.
Not quite. Fixes that fail's balancing loop runs through the variable its side effect leaves from, the symptomatic solution. B2 runs through urban areas that facilitate activity, the fundamental solution, and the side effect leaves from the spaces on the outskirts.

QUESTION 2 OF 3

More impression that spaces won't raise activity: what does it change, and through which loop?

- a More activity spaces on the outskirts, through its own effect on them.
Not quite. No effect runs from the impression to the spaces. Its one effect, a –, ends at urban areas that facilitate activity; the spaces rise only as the lack of activity does, around R1.
- b Nothing in the loops: a side effect sits outside them.
Not quite. R1 runs through it, from spaces left unused to urban areas that facilitate activity: the side effect is the reinforcing loop's middle, and without it R1 doesn't close.
- c Fewer urban areas that facilitate activity, so the lack of activity stays high: R1.
Yes. Its – effect lowers the fundamental solution: spaces left unused read as no interest, and less goes into areas close to home. B2 weakens, the lack of activity stays high, and more spaces go on the outskirts, closing R1.

QUESTION 3 OF 3

The figure has no delay, as its authors drew none. On which effect does shifting the burden's delay belong?

- a** Urban areas that facilitate activity → lack of adolescent physical activity.

Yes. Streets, squares and routes to school take years to rebuild, and habits of walking and playing outside follow later: the change in activity comes long after the change in the areas. With that delay, B2 relieves the problem symptom slowly while B1 seems to relieve it at once, and the spaces on the outskirts are built first.

- b** Activity spaces on the outskirts → lack of adolescent physical activity.

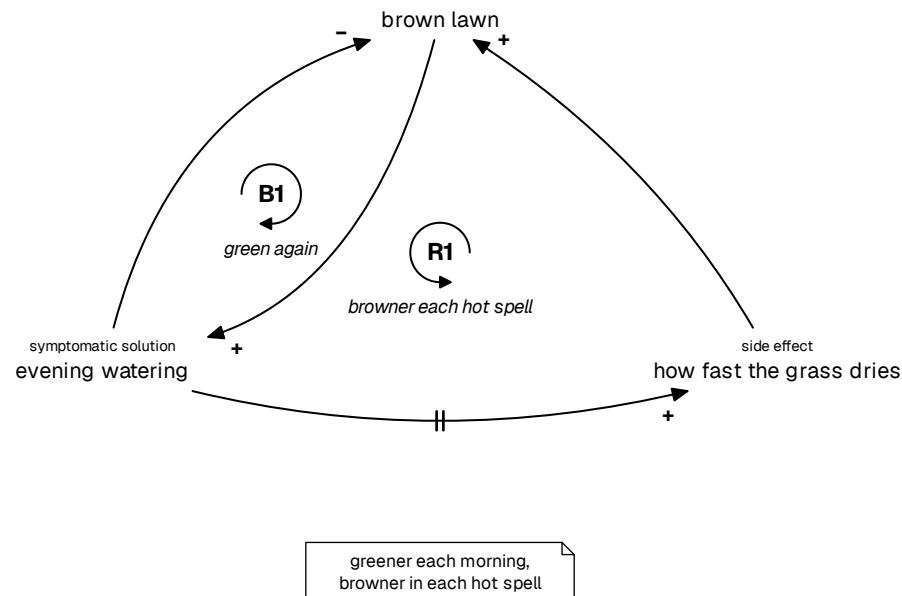
Not quite. That is the symptomatic solution's effect. Shifting the burden's symptomatic solution relieves at once; a delay there would take away the reason it is reached for first.

- c** Spaces left unused → impression that spaces won't raise activity.

Not quite. An impression may form over months, and a delay there would be a defensible addition. The archetype's own delay is the fundamental solution's, on B2, and the match lacks it.

AR 01 Watering a lawn a little every evening

Archetype: fixes that fail



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 browner the lawn, the more Rosa waters (+), and the more she waters, the less brown the lawn by morning (-): one – effect, so B1 is balancing. Over weeks the watering keeps the roots shallow, so the grass dries faster (+, with a delay), and the faster it dries, the browner the lawn (+): R1 has no – effect, so it is reinforcing. Evening watering is the symptomatic solution and how fast the grass dries the side effect; the declared archetype is fixes that fail, which the structure matches with its delay.

Why it works

- Both loops pass through the brown lawn, the change Rosa waters to undo
- One – effect makes the morning's relief balancing
- No – effect makes the return through the drying grass reinforcing
- The delay sits on evening watering → how fast the grass dries, where weeks pass
- Each role is written above its variable: the watering's and the drying grass's

Step by step

1. Brown lawn, drawn first: it is what Rosa sees each evening, before she waters.
2. Evening watering, the symptomatic solution, with a + effect from the brown lawn and a – effect back, closing B1, green again: the relief Rosa sees by the next morning.
3. How fast the grass dries, the side effect, with a + effect from the watering, delayed over the weeks the grass keeps its roots in the top few centimeters, and a + effect to the brown lawn, closing R1, browner each hot spell: drawn after B1, as it shows only after weeks of relief.

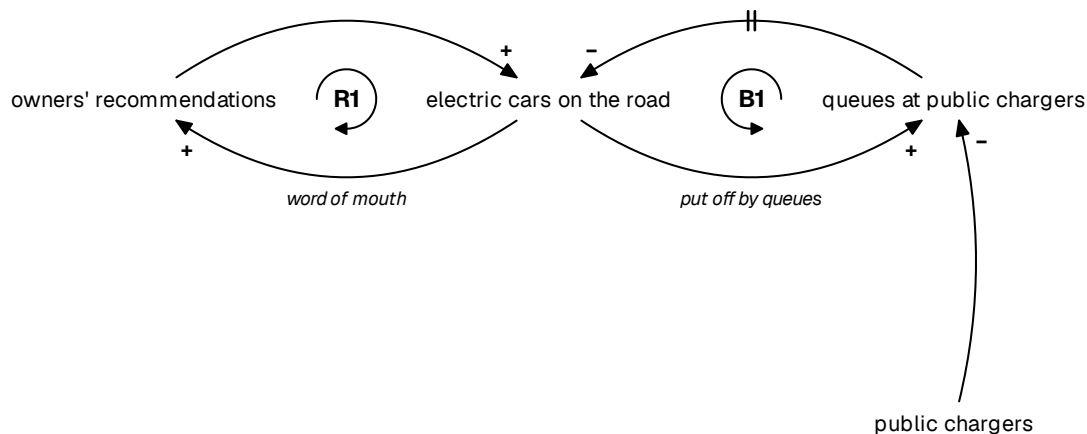
4. The behavior note, written once both loops are drawn, since each half of it comes from one: greener each morning from B1, browner in each hot spell from R1.
5. Fixes that fail, declared last: until R1 is drawn, the watering only fixes, and nothing fails.

What another defensible answer might vary

Another defensible answer might put the delay on how fast the grass dries → brown lawn, waiting for the next hot spell, or name the side effect how deep the grass grows, with – effects into and out of it: a variable named as its opposite, which keeps R1 reinforcing and still matches fixes that fail. What stays the same is a balancing loop of relief and a reinforcing loop, through the side effect and a delay, that returns to the brown lawn.

AR 02 Electric cars and public chargers

Archetype: limits to growth



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 more electric cars on the road, the more owners' recommendations (+), and the more recommendations, the more electric cars on the road (+): no – effect, so R1 is reinforcing. The more electric cars, the longer the queues at public chargers (+), and the longer the queues, the fewer electric cars join the road (–, with a delay): one – effect, so B1 is balancing. The two loops share only the electric cars on the road, so they match limits to growth: R1 grows the number of cars, and B1 holds it back. The public chargers shorten the queues (–) from outside both loops: the constraint.

Why it works

- R1 and B1 meet at one variable, the electric cars on the road, and share no effect
- No – effect makes the recommendations' loop reinforcing
- One – effect makes the queues' loop balancing
- The delay sits on queues at public chargers → electric cars on the road, where months pass before buyers hear
- The public chargers lie outside both loops and act on the balancing loop through the queues

Step by step

1. Electric cars on the road, drawn first: the number the situation begins and ends with.
2. Owners' recommendations, with a + effect each way to the cars, closing R1, word of mouth: the growth, drawn before anything holds it back.
3. Queues at public chargers, with a + effect from the cars and a – effect back, delayed by the months before word of hour-long waits reaches buyers, closing B1, put off by queues.

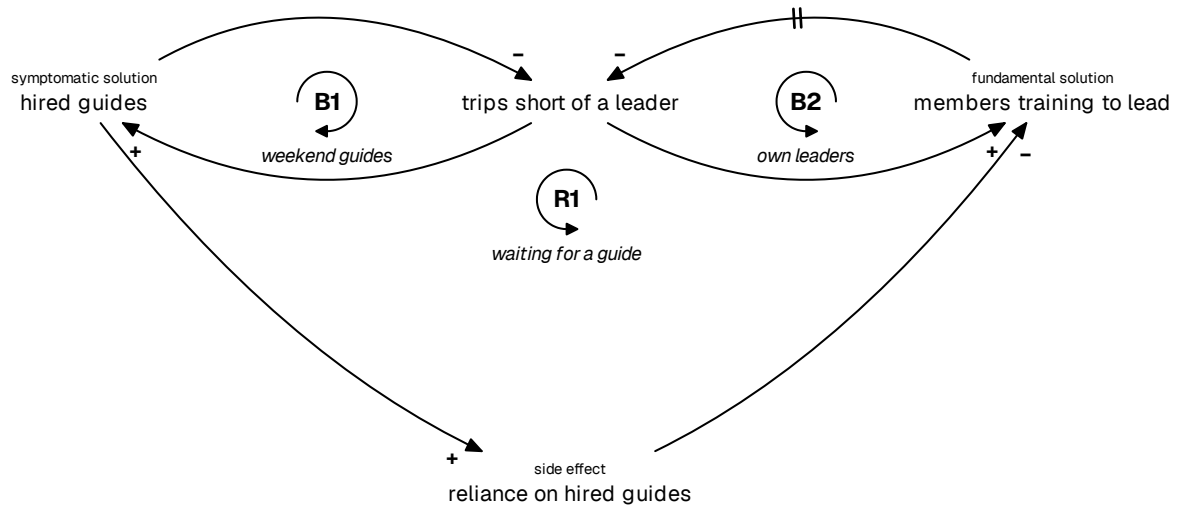
4. Public chargers, with a – effect on the queues, drawn last of the variables: no effect in either loop changes how many there are.
5. Limits to growth, declared once B1 is drawn: with R1 alone, the growth has nothing to limit it, and the drawing matches no archetype.

What another defensible answer might vary

Another defensible answer might name the queues as their opposite, a free charger when one is wanted, with the polarity of each effect into and out of it reversed: B1 stays balancing, and the match holds. Drawing the purchases as a variable both loops pass through would make them share an effect, and the structure would no longer match limits to growth. What stays the same is a reinforcing loop and a balancing loop that meet at one variable, with the chargers outside both.

AR 03 A climbing club that hires guides for its trips

Archetype: shifting the burden



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 more trips short of a leader, the more hired guides (+), and the more hired guides, the fewer trips short of a leader (-): one - effect, so B1 is balancing. The more trips short of a leader, the more members training to lead (+), and a season later, the more members training, the fewer trips short of a leader (-, with a delay): B2 is balancing too. The more hired guides, the more the club relies on them (+), and the more it relies on them, the fewer members train (-): R1 runs from the shortage through the hired guides, the reliance and the training back to the shortage, with two - effects, so it is reinforcing. Hired guides are the symptomatic solution, members training to lead the fundamental solution and the reliance on hired guides the side effect; the declared archetype is shifting the burden, which the structure matches with its delay, and fixes that fail within it.

Why it works

- Both balancing loops pass through the trips short of a leader, the shortage the hired guides and the training each relieve
- The delay sits on members training to lead → trips short of a leader, where a season passes
- Two - effects make R1, through the reliance, reinforcing
- The reliance on hired guides reaches the shortage only through the training, so the training's loop is the one it weakens
- Each role is written above its variable

Step by step

1. Trips short of a leader, drawn first: the club meets the shortage before it hires a guide or trains anyone.

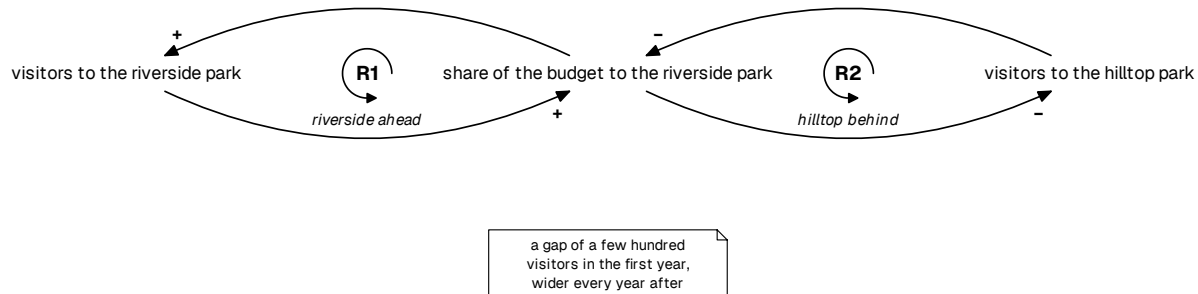
2. Hired guides, the symptomatic solution, with a + effect from the shortage and a – effect back, closing B1, weekend guides: a guide hired for the weekend lets that trip go ahead.
3. Members training to lead, the fundamental solution, with a + effect from the shortage and a – effect back, delayed by the season of courses and logged climbs, closing B2, own leaders.
4. Reliance on hired guides, the side effect, with a + effect from the guides and a – effect into the training, closing R1, waiting for a guide, which runs through B2's delayed effect and so comes after it.
5. Shifting the burden, declared last, once R1 is drawn: without it, the club has two ways to close the shortage, and nothing shifts the burden to the guides.

What another defensible answer might vary

Another defensible answer might draw the training as a chain, members training to lead → qualified leaders → trips short of a leader, with the delay on either effect, or name the side effect the club's self-reliance, with – effects into and out of it: a variable named as its opposite, which keeps R1 reinforcing and still matches shifting the burden. What stays the same is two balancing loops through the shortage, the slower one with its delay, and a reinforcing loop from the hired guides through the training.

AR 04 Two parks and one maintenance budget

Archetype: success to the successful



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 more visitors to the riverside park, the larger its share of the budget (+), and the larger that share, the more visitors to the riverside park (+): no – effect, so R1 is reinforcing. The more visitors to the hilltop park, the smaller the riverside park's share (–), and the larger that share, the fewer visitors to the hilltop park (–): two – effects, so R2 is reinforcing too. Two reinforcing loops sharing one variable match success to the successful: the park ahead draws the larger share, and the gap of a few hundred visitors in the first year widens every year after.

Why it works

- The split of the budget is one variable, so both loops pass through it
- R2 has two – effects, an even number, so it is reinforcing as drawn
- The two loops mirror each other across the share, one for each park
- The note names the first year's small gap and its widening

Step by step

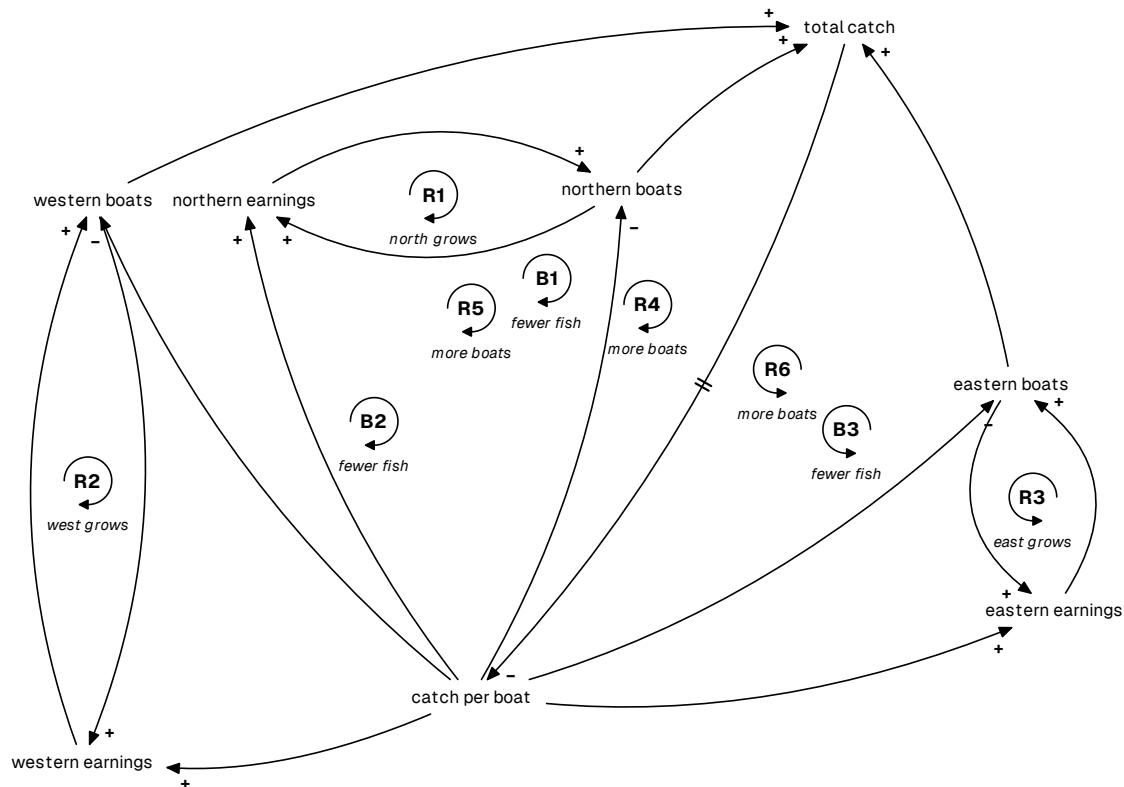
1. Share of the budget to the riverside park, drawn first: the council sets it each spring, and both parks' visitors depend on it.
2. Visitors to the riverside park, with a + effect each way to the share, closing R1, riverside ahead: the park ahead in the first year, so its loop comes first.
3. Visitors to the hilltop park, with a – effect each way to the share, closing R2, hilltop behind: the larger the riverside park's share, the less the hilltop park is mowed, cleaned and repaired.
4. The behavior note under the share, written once both loops are drawn: the gap it names is between the visitors R1 adds and those R2 takes away.
5. Success to the successful, declared last, once R2 holds the hilltop park back by the same split: R1 alone is one park's growth.

What another defensible answer might vary

Another defensible answer might draw the share as the hilltop park's share of the budget, with the polarity of each effect reversed: both loops stay reinforcing, and the match holds. Or it might draw each park's upkeep between the share and its visitors, as a chain of two effects. What stays the same is one variable for the split and two reinforcing loops through it.

AR 05 Three countries' fleets on one fishing ground

Archetype: tragedy of the commons



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 more northern boats, the more northern earnings (+), and the more northern earnings, the more northern boats (+): no – effect, so R1 is reinforcing, and R2 and R3 are the western and eastern fleets' loops. Each fleet's boats add to the total catch (+); the larger the total catch, the smaller the catch per boat, years later (–, with a delay); and the larger the catch per boat, the more each fleet earns (+): B1, B2 and B3 run through one fleet's boats and earnings each, with one – effect, so each is balancing. The smaller the catch per boat, the more boats each fleet sends (–): R4, R5 and R6 run from one fleet's boats through the total catch and the catch per boat, with two – effects, so each is reinforcing. Each pair of fleets matches tragedy of the commons, so the structure matches it three times, once for each pair, each with its delay.

Why it works

- One total catch and one catch per boat are shared by every fleet's balancing loop
- Each balancing loop's one – effect is the total catch's on the catch per boat; each loop back to a fleet's boats from the catch per boat adds a second, so it is reinforcing
- The delay sits on total catch → catch per boat, where the missing young fish take years to show
- Three fleets make three pairs, and each pair is one match of tragedy of the commons
- The fleets sit around the shared pair of variables, so no effect crosses another

Step by step

1. Northern boats and earnings, with a + effect each way, closing R1, north grows: the owners spend what they earn on more boats.

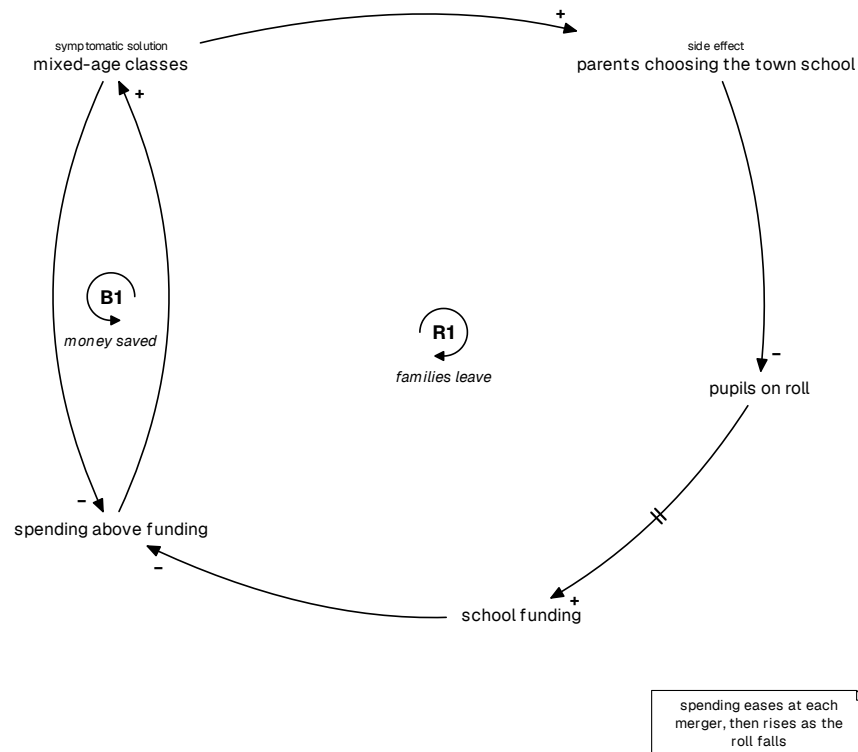
2. The western and eastern boats and earnings, closing R2, west grows, and R3, east grows: each fleet growing on its own until something the three share holds them back.
3. Total catch, with a + effect from each fleet's boats: the one place the three fleets' growth meets, drawn once.
4. Catch per boat, with a – effect from the total catch, delayed by years, and a + effect to each fleet's earnings, closing B1, B2 and B3, fewer fish.
5. A – effect from the catch per boat to each fleet's boats, closing R4, R5 and R6, more boats: drawn after the balancing loops, as a fleet sends more boats only once its catch per boat has fallen.
6. Tragedy of the commons, declared last: no one fleet's loops match it; two fleets' loops drawing on the one catch per boat do.

What another defensible answer might vary

Another defensible answer might draw the fish left to breed between the total catch and the catch per boat, as a chain of two effects with the delay on either, or name each fleet's earnings as its losses, with the polarity of each effect into and out of them reversed: every loop keeps its kind, and the three matches hold. What stays the same is one total catch fed by all three fleets, one catch per boat falling from it after a delay, and two reinforcing loops for each fleet.

CS 10 Kelsham Primary School: merging classes to balance the budget

Archetype: fixes that fail



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 more spending above funding, the more mixed-age classes (+), and the more mixed-age classes, the less spending above funding (-): one - effect, so B1 is balancing, and the saving comes at once. The more mixed-age classes, the more parents choosing the town school (+), the fewer pupils on roll (-), the less school funding a year later (+, with a delay), and the more spending above funding (-): R1 has two - effects, so it is reinforcing. Mixed-age classes are the symptomatic solution and parents choosing the town school the side effect; the declared archetype is fixes that fail, which the structure matches with its delay.

Why it works

- Both loops pass through spending above funding, the change the governors merge classes to undo
- One - effect makes the saving balancing; two make the families' leaving reinforcing
- The delay sits on pupils on roll → school funding: each October's count sets the next school year's funding
- Each role is written above its variable: the merged classes' and the parents' choice
- The note names the saving at each merger and the spending that comes back

Step by step

1. Spending above funding, drawn first: it is what the governors act on when they merge classes.
2. Mixed-age classes, the symptomatic solution, with a + effect from spending above funding and a - effect back, closing B1, money saved: merging Years 3 and 4 in 2023 saved £52,000 a year at once.
3. Parents choosing the town school, the side effect, then pupils on roll and school funding, with a + effect, a - effect, a + effect delayed by the October count and a - effect back to spending above funding, closing R1, families leave: drawn after B1, since the funding falls a year after the pupils leave.

4. The behavior note, written once both loops are drawn, since each half of it comes from one: spending eases at each merger, from B1, and rises as the roll falls, from R1.
5. Fixes that fail, declared last: until R1 is drawn, merging classes only saves money, and nothing fails.

What another defensible answer might vary

Another defensible answer might draw the school's reserve in place of spending above funding, with the polarity of each effect into and out of it reversed: a variable named as its opposite, which keeps both loops' kinds and still matches fixes that fail. Or it might draw teachers between spending above funding and mixed-age classes, or put a second delay on parents choosing the town school → pupils on roll, since families move at the end of a school year. What stays the same is a balancing loop of saving and a reinforcing loop, through the side effect and a delay, that returns to spending above funding.