

Shelf Life: level design workbook

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Every number here is measured from the 40 shipped levels (Assets/_Project/Resources/Levels.txt) by Tools/report.py, which plays the game's own rules. Nothing is estimated. Blue cells are inputs; the formulas update when you change them.

Sheet	What it shows
Levels	Every level: its shape (shelves, tall shelves, colours, books, tall volumes, cart, locked cases), its par and star thresholds, how open it is (best lines, opening odds, boards), what its newest mechanic adds, and how two bots fared.
Chapters	Each chapter's summary as formulas over the Levels sheet, and how the measures move together (correlations).
Tuning	The star rule's inputs (3 stars at par + margin, 2 stars within a wider margin). Change them and every threshold follows.
Findings	What the solver and the bots changed in the design, with the measurement behind each change.

Measures

Measure	Meaning
Par	The fewest moves that sort every shelf (breadth-first search over every board).
Best lines	How many different move sequences win in exactly par moves. Few = one narrow path to find; many = forgiving.
Opening odds	The share of the first moves available that lie on some best line.
Boards	How many different boards can be reached from the start at all, and within par moves.
Moves it adds	The level's newest mechanic (height, cart or locked case) switched off: every shelf tall, the cart a normal shelf, or the case unlocked. Par with it minus par without it; 'unsolvable' when the level can't be won without it. Every level with a focus is non-zero: the generator keeps no deal where the mechanic is decoration.
Random bot	Plays any legal move. 300 runs a level, capped at 300 moves. A run ends in a dead end when no legal move is left. Median moves are over the runs that won; the 3-star share is over all runs.
Greedy bot	Finishes a shelf when it can, otherwise plays a random legal move; looks no further. A floor for a careless player, not a model of a person.

Tuning: the star rule

Blue cells are inputs; the Levels sheet reads them.

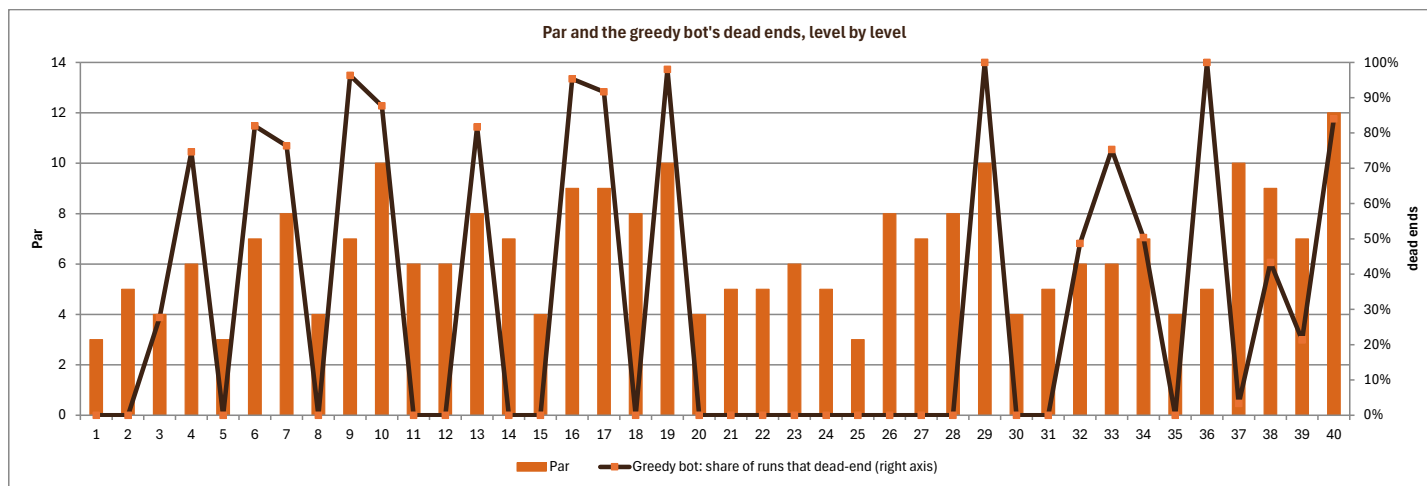
Input	Value	In the game
3 stars: at most par + this many moves		0 Stars.For: moves <= par
2 stars: at most par + this many moves		2 Stars.For: moves <= par + 2

The game uses 0 and 2. Unlike Clockwork, a move can't always be taken back: a book can only go onto its own colour, so a slip can leave no way home. A level never fails; the game names a dead end and restart is free. Whether an undo button is needed is a playtest question (see Findings).

Every level, measured

From Tools/report.py over the shipped level file. Green = easier, red = harder.

Level	Ch.	Name	Shelves	Tall shelves	Capacity	Colours	Books	Tall volume s	Cart	Locked cases	Focus	Par	3 stars up to	2 stars up to	Best lines	First moves	On a best line	Opening odds	Boards reachable	Boards within par	Par without focus	Moves it adds	Random bot: dead ends	Random bot: median moves	Random bot: 3-star share	Greedy bot: dead ends	Greedy bot: median moves	Greedy bot: 3-star share
1	1	First Shelf	3	0	3	2	6	0	0	0		3	3	5	6	4	3	75%	8	8			0%	3	62%	0%	3	78%
2	1	Three Colours	4	0	3	3	9	0	0	0		5	5	7	2	1	1	100%	22	18			0%	6	48%	0%	6	50%
3	1	Four Deep	3	0	4	2	8	0	0	0		4	4	6	2	2	1	50%	10	10			29%	5	27%	28%	4	48%
4	1	Tall Stories	4	2	3	3	9	1	0	0	height	6	6	8	1	1	1	100%	8	8	5	+1	72%	6	28%	75%	6	25%
5	1	Breather	3	0	3	2	6	0	0	0		3	3	5	2	1	1	100%	6	6			0%	4	50%	0%	3	100%
6	1	Atlases	4	2	3	3	9	2	0	0	height	7	7	9	1	1	1	100%	11	11	6	+1	84%	7	16%	82%	7	18%
7	1	Four Tall	4	2	4	3	12	1	0	0	height	8	8	10	2	2	2	100%	11	11	7	+1	76%	8	24%	76%	8	24%
8	1	Short Break	4	0	3	3	9	0	0	0		4	4	6	2	1	1	100%	7	7			0%	4	53%	0%	4	100%
9	1	Reading Room	5	2	3	4	12	2	0	0	height	7	7	9	1	2	1	50%	16	16	6	+1	96%	7	4%	96%	7	4%
10	1	The Archive	5	2	4	4	16	2	0	0	height	10	10	12	2	2	2	100%	19	19	9	+1	85%	11	8%	88%	11	5%
11	2	Five Colours	6	0	3	5	15	0	0	0		6	6	8	2	1	1	100%	18	16			0%	7	27%	0%	7	50%
12	2	Paperbacks	4	0	4	3	12	0	0	0		6	6	8	4	2	2	100%	29	23			0%	7	38%	0%	7	50%
13	2	Two Atlases	5	2	4	4	16	2	0	0	height	8	8	10	2	1	1	100%	21	21	7	+1	81%	8	19%	82%	8	18%
14	2	Encyclopaedias	5	3	3	4	12	4	0	0	height	7	7	9	4	2	2	100%	13	13	6	+1	0%	7	100%	0%	7	100%
15	2	Quiet Corner	4	0	3	3	9	0	0	0		4	4	6	2	1	1	100%	7	7			0%	5	49%	0%	4	100%
16	2	Mixed Heights	5	2	4	4	16	2	0	0	height	9	9	11	3	3	1	33%	32	32	7	+2	96%	10	1%	95%	9	3%
17	2	Full House	6	2	3	5	15	2	0	0	height	9	9	11	1	2	1	50%	17	17	8	+1	93%	9	7%	92%	9	8%
18	2	The Stacks	5	2	3	4	12	2	0	0	height	8	8	10	2	1	1	100%	27	26	7	+1	0%	9	48%	0%	8	51%
19	2	Grand Atlas	4	2	4	3	12	1	0	0	height	10	10	12	1	1	1	100%	19	19	8	+2	97%	10	3%	98%	10	2%
20	2	Closing Time	4	0	3	3	9	0	0	0		4	4	6	6	2	2	100%	10	10			0%	5	49%	0%	4	100%
21	3	Returns	4	1	3	2	6	0	1	0	cart	5	5	7	74	4	4	100%	67	56	4	+1	0%	6	41%	0%	5	62%
22	3	Trolley Dash	5	1	3	3	9	0	1	0	cart	5	5	7	44	3	3	100%	119	87	4	+1	0%	7	13%	0%	6	38%
23	3	Tall Returns	5	3	3	3	9	1	1	0	cart	6	6	8	29	6	2	33%	436	167	5	+1	0%	8	5%	0%	7	22%
24	3	Heavy Cart	4	1	4	2	8	0	1	0	cart	5	5	7	44	4	3	75%	90	74	4	+1	0%	6	11%	0%	6	37%
25	3	Catch Up	4	1	3	2	6	0	1	0	cart	3	3	5	6	3	2	67%	26	17	none	unsolvable	0%	3	55%	0%	3	68%
26	3	Book Drop	5	1	3	3	9	0	1	0	cart	8	8	10	948	6	6	100%	506	426	7	+1	0%	11	12%	0%	9	29%
27	3	Late Returns	5	3	4	3	12	1	1	0	cart	7	7	9	500	3	3	100%	442	324	6	+1	0%	8	26%	0%	7	58%
28	3	Tea Trolley	6	1	3	4	12	0	1	0	cart	8	8	10	200	2	2	100%	857	351	7	+1	0%	9	36%	0%	9	46%
29	3	Overdue	6	3	3	4	12	2	1	0	cart	10	10	12	36	4	3	75%	142	142	9	+1	99%	15	0%	100%	no win	0%
30	3	Lunch Break	4	1	3	2	6	0	1	0	cart	4	4	6	8	4	2	50%	44	31	none	unsolvable	0%	5	20%	0%	5	36%
31	4	Locked Case	5	0	3	3	9	0	0	1	locked case	5	5	7	4	4	1	25%	76	35	4	+1	0%	8	3%	0%	7	15%
32	4	In Order	5	0	3	3	9	0	0	1	locked case	6	6	8	16	3	1	33%	173	71	5	+1	52%	9	3%	49%	8	13%
33	4	Glass Case	5	3	3	3	9	1	0	1	locked case	6	6	8	28	4	3	75%	31	25	5	+1	69%	8	4%	75%	6	25%
34	4	Two Keys	7	0	3	4	12	0	0	2	locked case	7	7	9	288	4	1	25%	5,736	1,335	6	+1	51%	13	0%	50%	9	5%
35	4	Respite	4	0	3	2	6	0	0	1		4	4	6	4	2	1	50%	36	22			0%	6	11%	0%	5	28%
36	4	Cart and Key	5	1	3	3	9	0	1	1	locked case	5	5	7	36	4	3	75%	73	46	4	+1	45%	5	29%	100%	no win	0%
37	4	Special Collection	6	3	4	4	16	1	0	1	locked case	10	10	12	180	1	1	100%	3,258	1,062	9	+1	2%	17	1%	3%	14	5%
38	4	Rare Books	6	4	3	4	12	2	1	1	locked case	9	9	11	92	2	1	50%	422	286	8	+1	37%	13	1%	43%	12	6%
39	4	Last Light	5	3	3	3	9	1	0	1	locked case	7	7	9	26	2	2	100%	185	86	6	+1	17%	9	9%	21%	8	19%
40	4	The Head Librarian	6	4	4	4	16	1	1	1	locked case	12	12	14	576	4	2	50%	710	405	11	+1	87%	15	1%	84%	14	4%



Chapters: the shape of the curve

Formulas over the Levels sheet.

Chapter	Name	Levels	Average par	Lowest par	Highest par	Levels with tall volumes	Levels with the cart	Levels with locked cases	Average best lines	Average opening odds	Greedy bot: average dead ends	Greedy bot: average 3-star share
1	The Shelves	10	5.7	3	10	5	0	0	2	88%	44%	45%
2	Bigger Collections	10	7.1	4	10	6	0	0	3	88%	37%	48%
3	The Returns Cart	10	6.1	3	10	3	10	0	189	80%	10%	40%
4	Locked Cases	10	7.1	4	12	5	3	10	125	58%	43%	12%

What moves together (Pearson correlation over the 40 levels)

Pair	r
Tall volumes and the greedy bot's dead ends	0.49
Par and the greedy bot's dead ends	0.58
Par and the greedy bot's 3-star share	-0.65
Colours and the greedy bot's 3-star share	-0.38
Par and the number of best lines	0.35

How to read it: par is the designed difficulty; the bots show where a careless player gets stuck. In Shelf Life the bots rarely wander, they dead-end: a level with a modest par and a high dead-end share punishes guessing more than its par suggests. Those are the levels to watch first in playtests.



What the measurements changed

Shelf Life has not been playtested by people yet; every finding here comes from the solver and the bots.

Finding	What the measurement showed	What changed
Height per colour did nothing	With whole sets tall or short, the rule never changed a best line when tall shelves were plentiful, and with few tall shelves almost every deal was unsolvable.	Mixed heights within a set: a set with a tall volume must finish on a tall shelf. A deal is kept only if the rule changes its best line.
An empty reserved shelf was decoration	Tools/probe.py: it changed the best line in at most a handful of 500 deals, and in none of the small layouts an introduction needs.	The locked case holds books instead, which forces an order: 16 to 123 of 500 deals passed.
Height's real job is dead ends	The greedy bot dead-ends in 75–98% of its runs on 9 of 11 height levels; levels 14 and 18 stay open.	The game now spots a dead end (no legal move left), says so and pulses the restart button.
Two levels where the greedy bot never wins	Levels 29 and 36: the greedy bot dead-ends in every run; the random bot wins 1% on 29 and 55% on 36.	Kept, as late-chapter peaks that reward looking ahead; first on the watch list for playtests.
A new rule arrives on an easy level	Clockwork's playtest: a rule introduced on a hard level read as a difficulty spike. Here the first tall volume is on level 4 (par 6), the cart on 21 (par 5), the locked case on 31 (par 5).	A 7-move first locked-case level was rejected for a 5-move one; each chapter ends on its hardest level.
Still open: undo	Levels reach a par of 12, and a slip can't always be taken back.	Decide after the first playtest, from the dead_end and restart events (Ad Test and KPI Plan).