Fold-flat document tray

One invented design

The proposed product is a tool-free fold-flat document tray for shared offices. A product mission and source-linked needs lead to measured requirements, alternative concepts, a controlled revision and separate verification decisions. Every user, observation, reading and outcome is fictional.

What the selected cards show

Twenty-one completed cards trace the decisions through five DMADV gates. The separate blank workbook has ninety-five cards. The completed example deliberately retains failures, unresolved safety questions and measurement limits instead of presenting a polished success story.

Concept and exploration

A detachable-panel concept scores 3.05 and a captive folding-panel concept scores 3.80 under explicit teaching weights. An eight-reading two-factor exploration favors a higher front rib and hinge wall; it is descriptive evidence, not a population effect estimate.

Verification

The frozen teaching revision has observed pass counts of 58/60 load, 47/50 setup, 30/30 folded thickness and 57/60 hinge cycles. The stated observed-sample decision rules pass. No commercial safety approval or reliability guarantee follows from these invented observations.

Concept and verification arithmetic

Criterion weights

Sum = 0.35 + 0.25 + 0.20 + 0.10 + 0.10 = 1.00.

Concept A

Weighted score = sum(weight x rating) = .35x3 + .25x2 + .20x4 + .10x3 + .10x4 = 3.05.

Concept B

Weighted score = .35x4 + .25x4 + .20x4 + .10x3 + .10x3 = 3.80. Difference = 3.80 - 3.05 = 0.75 points.

Two-factor cell means

Mean = sum(readings)/2. LL=(4.9+4.7)/2=4.8; LH=(4.5+4.3)/2=4.4; HL=(4.0+3.8)/2=3.9; HH=(3.6+3.4)/2=3.5 mm.

Descriptive factor effects

Rib = (3.9+3.5)/2-(4.8+4.4)/2=-0.9 mm. Hinge = (4.4+3.5)/2-(4.8+3.9)/2=-0.4 mm.

Observed verification shares

Rate = passes/sample. Load 58/60=96.67%; setup 47/50=94.00%; thickness 30/30=100.00%; cycles 57/60=95.00%.

Minimum pass counts

Required passes = ceil(sample x floor). Load ceil(60x.95)=57; setup ceil(50x.90)=45; thickness ceil(30x.95)=29; cycles ceil(60x.95)=57.

How to read the filled cards

Evidence identifiers

Invented specimen and requirement IDs illustrate traceability. A live team would retain controlled interview notes, drawings, build travelers, individual readings, deviations, failures, approvals and sample-selection records, with appropriate access and retention rules.

Validity

Concept scores are judgments. The exploratory measurements are a small, intentionally constructed set without random build order or inferential power. Verification pass shares are descriptive counts under specified test conditions and are not guarantees about a market population.

Safety

A prototype can pass four numeric CTQs and still expose a pinch, sharp edge or tipping hazard. A real user session needs consent and a stop rule; external release needs independent local engineering and applicable legal or regulatory review.

Decision record

The completed teaching project ends in a conditional design gate. A new hinge or rib revision would reopen affected tests; a real product launch is beyond this fictional record.

Product mission and charter

FICTIONAL RECORD | Selected design decision trail

1. Product purpose and user

Design a fold-flat document tray for temporary paper storage at shared desks; users set it up, retrieve documents and store it between sessions.

2. In-scope functions

In scope: a tool-free tray, captive panels, paper support and folding action. In-scope interface: a level desktop and a specified paper load.

3. Out-of-scope functions

Out of scope: powered sorting, permanent furniture, customer filing systems and a commercial safety certification claim.

4. Target date and resources

Teaching project only. The design lead and test lead have time for a controlled prototype sequence; no real budget or launch date is asserted.

5. Sponsor and gate authority

The fictional sponsor approves the Define, Measure, Analyze, Design and Verify gates; the safety reviewer may stop a user trial.

Problem and need statement

FICTIONAL RECORD | Selected design decision trail

1. User and job

A shared-office user needs to hold and retrieve a temporary stack of papers while moving among desks.

2. Unsatisfactory outcome

Loose joining parts can be lost, an unstable tray can sag, and a bulky form takes storage space.

3. When it occurs

The problem appears during tool-free deployment, loaded use and fold-away storage on a typical shared desk.

4. Evidence and frequency

Synthetic teaching evidence consists of invented interview notes and task observations; no prevalence estimate is claimed.

5. Solution-neutral formulation

Design a stable, quickly deployable and compact temporary paper holder, leaving the particular joining principle open.

Define decision gate

FICTIONAL RECORD | Selected design decision trail

1. Need and evidence version

Source-linked fictional needs are grouped as stability, setup, storage, safe handling and repeat use.

2. Approved product boundary

The product boundary includes one tabletop tray and its panels, excluding the desk, powered components and other filing equipment.

3. Unknowns and risks

Open questions are load stiffness, folding-joint wear, hand safety and variation in user assembly.

4. Sponsor decision

The fictional sponsor approves the mission conditionally, with independent safety review required before external use.

5. Next phase owner and date

Measure owner will define units, thresholds, fixtures and sampling before choosing the final architecture.

CTQ operational definition

FICTIONAL RECORD | Selected design decision trail

1. Part or user as unit

For load and hinge tests the unit is one uniquely identified frozen-revision specimen; for setup it is one participant and one prescribed attempt.

2. Fixture and conditions

Load: 3 kg in a prescribed position on a level fixture. Setup: parts presented with the same instruction. Cycle test: one open-close pair.

3. Measurement location

Deflection is read at the front edge in millimeters; setup is timed in seconds; folded thickness is measured in millimeters.

4. Pass rule and threshold

Per-specimen limits: deflection <= 4.0 mm, setup <= 90 s, folded thickness <= 22 mm, functional hinge after 100 cycles.

5. Version and owner

The test lead controls the protocol revision, instrument checks, deviation log and acceptance count definitions.

Sample size and acceptance rule

FICTIONAL RECORD | Selected design decision trail

1. Population claim sought

The sample rules concern observed performance under specified conditions; no population confidence claim is planned.

2. Unit and selection

Preselect 60 load specimens, 50 setup participants, 30 thickness specimens and 60 hinge specimens. Record selection and all failures.

3. Planned sample count

Load: ceil(60 x .95) = 57 passes. Setup: ceil(50 x .90) = 45. Thickness: ceil(30 x .95) = 29. Cycles: ceil(60 x .95) = 57.

4. Pass count threshold

These pass counts are decision rules for the constructed sample, not demonstrations of an underlying 95% reliability level.

5. What evidence cannot prove

If a sample count changes, reset its minimum pass count before observing the replacement data and document why.

Measure decision gate

FICTIONAL RECORD | Selected design decision trail

1. Approved CTQs and units

CTQs approved: deflection <=4.0 mm at 3 kg; setup <=90 s; folded thickness <=22 mm; hinge functional after 100 cycles.

2. Test methods and samples

Sample units, fixtures, timing boundaries, failure definitions and recorded design revision have designated protocols.

3. Unresolved measurement risk

The fictional gauge check needs adequate resolution near 4.0 mm; recruitment does not represent all future user abilities.

4. Decision and reason

Decision: proceed with concept analysis while retaining measurement and sampling limitations in the gate record.

5. Next phase owner

Analyze owner must examine alternatives, structural trade-offs, assembly errors and safety risks.

Weighted concept criteria

FICTIONAL RECORD | Selected design decision trail

1. Criterion definition

Criteria are load stability, setup, folded storage, serviceability and illustrative unit cost.

2. Weight and source

Weights are 0.35, 0.25, 0.20, 0.10 and 0.10. Sum = 0.35+0.25+0.20+0.10+0.10 = 1.00.

3. Score anchor 1 to 5

Ratings range from 1 (weak fit to the defined task) to 5 (strong fit); evidence combines early observations and engineering judgment.

4. Conflict or dependence

Storage and setup may covary; the scores are an explicit decision aid, not independent measured response variables.

5. Approval of scoring plan

The design team approves weights before concept scoring and commits to rerun the ranking when physical tests challenge them.

Concept decision matrix

FICTIONAL RECORD | Selected design decision trail

1. Concept and criterion scores

Concept A uses detachable walls and loose clips. Ratings [3,2,4,3,4]. Concept B uses captive folding panels. Ratings [4,4,4,3,3].

2. Weighted-sum formula

A = .35x3 + .25x2 + .20x4 + .10x3 + .10x4 = 3.05. B = .35x4 + .25x4 + .20x4 + .10x3 + .10x3 = 3.80.

3. Evidence for scores

The 0.75-point lead reflects assigned scores and weights. It is not an empirical performance margin or a significance test.

4. Smallest winning margin

If cost rises to dominate or the folding joint proves unsafe, recalculate weights and scores rather than retaining a stale winner.

5. Next prototype question

Select B for prototype exploration, with stiffness, pinch and wear risks explicitly unresolved.

Exploratory experiment plan

FICTIONAL RECORD | Selected design decision trail

1. Factors and levels

Explore rib height and hinge-wall thickness at two settings each. Levels are coded L and H; this is an illustrative design comparison.

2. Response and unit

Response is front-edge deflection in mm under the same 3 kg load. Readings are LL 4.9/4.7; LH 4.5/4.3; HL 4.0/3.8; HH 3.6/3.4.

3. Run order

Record four factor combinations, two independent invented build readings per combination, specimen IDs and a prespecified fixture rule.

4. Replicate rule

A real test would randomize build and measurement order and report instrument and batch effects; the teaching values are not randomized data.

5. Confounding and limitation

Use the contrasts descriptively to select a promising build, then test a frozen revision independently in Verify.

Exploratory effect calculation

FICTIONAL RECORD | Selected design decision trail

1. Cell means

Cell means in mm: LL=(4.9+4.7)/2=4.8; LH=(4.5+4.3)/2=4.4; HL=(4.0+3.8)/2=3.9; HH=(3.6+3.4)/2=3.5.

2. Factor effect formula

Rib effect = (3.9+3.5)/2 - (4.8+4.4)/2 = 3.7 - 4.6 = -0.9 mm.

3. Repeat spread

Hinge effect = (4.4+3.5)/2 - (4.8+3.9)/2 = 3.95 - 4.35 = -0.4 mm. Replicate pairs differ by 0.2 mm in each cell.

4. Interaction question

Difference of differences = (3.5-3.9) - (4.4-4.8) = 0.0 mm, a descriptive zero interaction in these fabricated values.

5. No-inference warning

A small nonrandom exploration supports selecting high/high for a controlled next prototype. It does not establish population effects.

Analyze decision gate

FICTIONAL RECORD | Selected design decision trail

1. Chosen concept and score

Concept B leads by 3.80-3.05 = 0.75 weighted points under predeclared teaching weights and ratings.

2. Critical unresolved trade-off

A high rib and high hinge-wall setting has the lowest observed cell mean, 3.5 mm, in the eight-value exploration.

3. Risk controls to design

A thicker hinge could alter folding force and thickness, while a captive joint still poses pinch and wear concerns.

4. Decision owner

The fictional design lead conditionally chooses B high/high and requires tolerance, user-error and safety controls.

5. Reopen condition

Reopen architecture selection if a later frozen-revision test fails or a safety review finds an unacceptable hazard.

System design specification

FICTIONAL RECORD | Selected design decision trail

1. Product functions

The design supports temporary documents, unfolds without tools, stands on a level desk and stores flat.

2. Performance limits

Critical per-unit limits are 4.0 mm load deflection, 90 s setup, 22 mm folded thickness and hinge function at 100 cycles.

3. Interfaces and materials

Controlled interfaces are base to captive side panels, panel lock to user hand, tray to desk and parts to test fixture.

4. Assumed use envelope

The intended setting is shared-office indoor use. The fictional sample is not a basis for all environments or user groups.

5. Approval and version

The design lead records the frozen teaching revision B-HH-R2 for Verify and retains older revisions as historical evidence.

Verification matrix design

FICTIONAL RECORD | Selected design decision trail

1. Requirement ID

REQ-01 load: <=4.0 mm under 3 kg, 60 frozen-revision specimens, at least 57 passing; protocol VT-01.

2. Pass threshold

REQ-02 setup: <=90 s, 50 users, at least 45 passing; protocol VT-02 with safety stop.

3. Protocol and sample

REQ-03 storage: <=22 mm, 30 frozen-revision specimens, at least 29 passing; protocol VT-03.

4. Record location

REQ-04 cycles: functional after 100 open-close pairs, 60 specimens, at least 57 passing; protocol VT-04.

5. Approval owner

The test lead owns raw records; the safety reviewer evaluates hazards independently of the numeric CTQ gate.

Design decision gate

FICTIONAL RECORD | Selected design decision trail

1. Frozen revision

Freeze revision B-HH-R2 with captive panels, strengthened front rib, controlled joint clearance and traceable drawing IDs.

2. Critical risks addressed

Pinch, edge, tipping and wear risks have proposed controls; they still require direct safety and use evaluation.

3. Test protocols ready

The four test protocols, specimen definitions and pass counts are recorded before final measurements are entered.

4. Decision and deviations

The design lead authorizes a controlled Verify run; commercial release is not authorized by this gate.

5. Verify owner

Any geometric change after this point receives a new revision and an explicit affected-test recheck.

Verification master protocol

FICTIONAL RECORD | Selected design decision trail

1. Revision and test population

Only frozen B-HH-R2 specimens enter the reported physical CTQ tests; user setup participants see consistent instructions.

2. Each CTQ threshold

Per-unit criteria are <=4.0 mm, <=90 s, <=22 mm and hinge function after 100 cycles; observed floors are .95, .90, .95, .95.

3. Sample and selection

Planned counts are 60, 50, 30 and 60. Minimum passes are 57, 45, 29 and 57 respectively.

4. Deviation and stop rule

Record every failure, deviation and safety event; stop a user session immediately for a concerning pinch, edge or tipping event.

5. Signatures before data

Test lead and safety reviewer approve protocol and sample rules before seeing verification counts.

Loaded deflection verification

FICTIONAL RECORD | Selected design decision trail

1. Specimen ID and revision

Sixty unique B-HH-R2 specimens are identified in the controlled teaching sample.

2. Load and position

Each receives a 3 kg paper load on the specified level fixture; the same front-edge location is read in mm.

3. Measured mm

Fifty-eight readings are <=4.0 mm; two exceed 4.0 mm and remain in the denominator.

4. Pass or fail

Observed pass share = 58/60 x 100 = 96.67%; required count = ceil(60 x .95) = 57, so the sample rule passes.

5. Deviation and reviewer

The result supports this test under its conditions; it is not a 95% population guarantee.

Tool-free assembly user test

FICTIONAL RECORD | Selected design decision trail

1. Participant code and context

Fifty fictional participants complete one prescribed tool-free assembly attempt with the same instruction.

2. Start and stop times

The timer starts on presentation of parts and stops when the tray stands ready; incomplete attempts are failures.

3. Completion or failure

Forty-seven complete correctly within 90 seconds and three do not meet the criterion.

4. Instruction deviation

Observed pass share = 47/50 x 100 = 94.00%; required count = ceil(50 x .90) = 45, so the sample rule passes.

5. Observer and safety note

No incident is recorded in the invented sessions; real testing needs consent, accommodation and an active safety stop.

Folded thickness verification

FICTIONAL RECORD | Selected design decision trail

1. Specimen ID

Thirty frozen-revision specimens are folded to the specified state before thickness measurement.

2. Fold condition

The closure force and location are held consistent for all specimens in the teaching protocol.

3. Thickness in mm

Every specimen reads at or below the 22 mm limit in the invented record.

4. Pass or fail

Observed pass share = 30/30 x 100 = 100.00%; required count = ceil(30 x .95) = 29, so the rule passes.

5. Damage or deviation

All passing in thirty observations does not establish a zero population failure probability.

Hinge-cycle verification

FICTIONAL RECORD | Selected design decision trail

1. Specimen ID

Sixty frozen-revision specimens are followed with unique IDs through the planned hinge test.

2. Cycles completed

One cycle is an open-close pair; a specimen passes if the hinge remains functional after 100 cycles.

3. Failure definition

Fifty-seven function after 100 cycles; three fail and remain in the denominator with failure notes.

4. Pass or fail

Observed pass share = 57/60 x 100 = 95.00%; required count = ceil(60 x .95) = 57, so the rule passes exactly.

5. Failure mode

The observation is at 100 laboratory cycles only; real-life service life and population reliability remain unproven.

Product release decision

FICTIONAL RECORD | Selected design decision trail

1. Pass rules and results

Observed rules pass: load 58/60, setup 47/50, thickness 30/30 and hinge cycles 57/60.

2. Safety review status

The safety review remains a separate release condition; zero incidents in an invented trial cannot close a hazard.

3. Deviation treatment

No failed specimen is removed. Any genuine protocol deviation would receive a documented disposition and possible retest.

4. Approver and date

The fictional sponsor approves the teaching design gate, not a commercial product release, on the stated date.

5. Conditions for release

External use requires local engineering, product safety, legal and regulatory review of real samples.

Verify decision gate

FICTIONAL RECORD | Selected design decision trail

1. Frozen revision and result list

The reported design revision is B-HH-R2; requirements, protocols and observed counts are linked by the verification matrix.

2. Threshold and uncertainty

Observed thresholds are met, but the samples do not validate a population reliability claim or absence of rare hazards.

3. Residual hazard owner

A named safety reviewer owns unresolved edge, pinch and tipping analysis before external trials.

4. Decision and restrictions

Disposition: complete the fictional educational project with a conditional design transfer record; do not claim commercial approval.

5. Archive and next review

Archive drawings, measurement definitions, raw test records, failures, gate decisions and the next real-world review route.