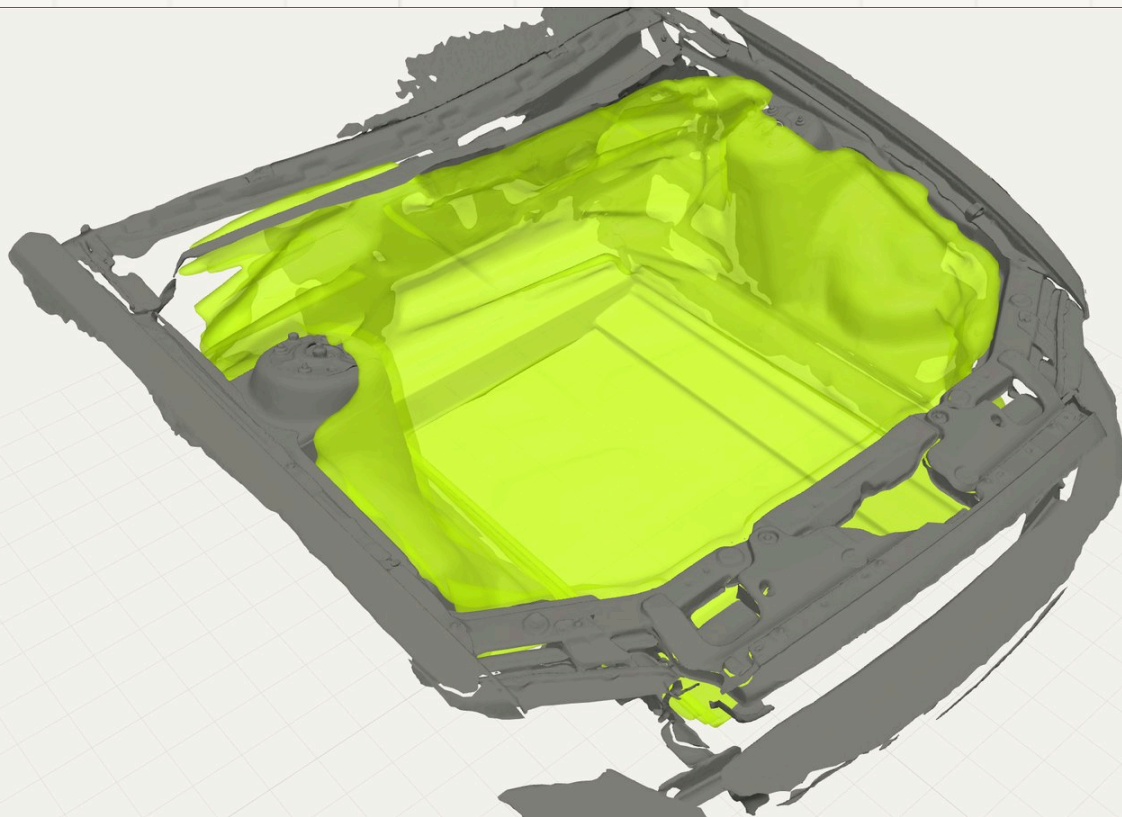


SCAN → PACKAGING • AUTOMOTIVE

An empty bay. Mapped.

Engine out, nothing in its place yet. We scanned the stripped bay, set datums you can find again with a tape measure, put both hoods from case study 01 back on, and mapped the free space that's left to design into.

**±2_{mm}**HARDPOINTS
RE-MEASURABLE ON THE CAR**0.45_{mm}**HOOD SHUT-LINE FIT
RMS, 165 POINTS**518_L**FREE SPACE UNDER THE HOOD
≥10 MM OFF EVERY SURFACE**15**FAILURE MODES LOGGED
8 FIXED BEFORE DELIVERY

Client and vehicle details withheld. Images and figures are shared with permission.

01 The brief

Same car as case study 01. The engine is out, and before anything new goes in, whether that's brackets, ducting, a cooling package or a whole drivetrain, the client needs to know what space is really there, and where it's measured from.

The job wasn't to rebuild the sheet metal. It was a **packaging reference**: datums and hardpoints you can find again on the car, a free-space envelope you can design straight into, and the hood back on top, because the hood is the lid on all of it.

02 How we ran it

01 Scan

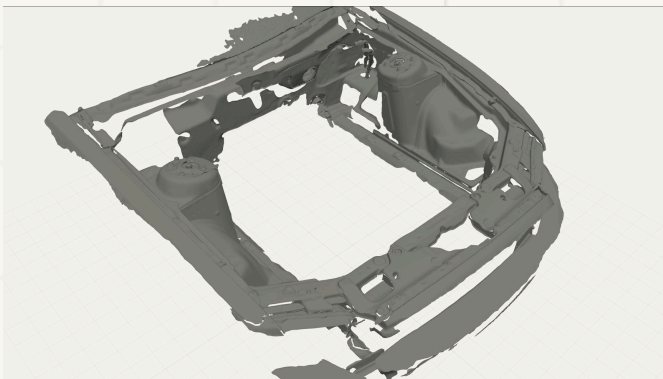
The whole bay at about 1 mm spacing, plus a second pass over the front. Merged where they agree; the second pass fills what the first missed.

02 Set datums

Centreline from the bay's mirror plane, height from the frame-rail tops, fore-aft from the strut-mount bolt patterns.

03 Find hardpoints

Stud patterns, rail walls, core-support and firewall faces, the latch pocket. Every number tagged with its source and uncertainty.



SCAN The stripped bay as captured, two passes merged.

PART	stripped engine bay
SCANS	full bay + front-section pass
HOODS	both, from case study 01
INPUT	Einstar Vega · 7.1M triangles
TOOLCHAIN	Python · Open3D · OpenCascade
OUTPUT	STEP · STL · hardpoint CSV

same loop · different question

04 Map free space

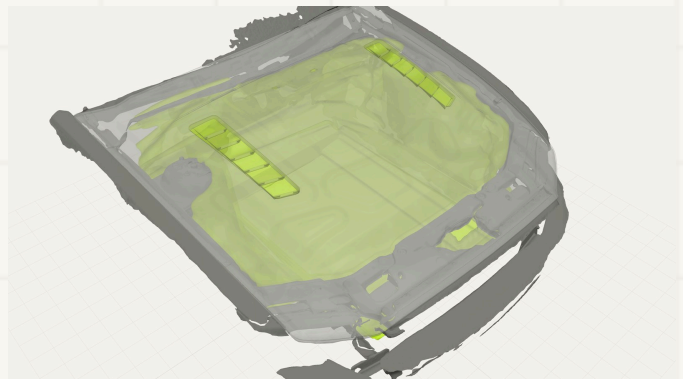
Rays from the centreline and 5 mm voxels, kept 10 mm off every scanned surface. Scan holes are bridged, and the bridged areas mapped.

05 Put the hood back

Each hood's edge is fitted to the fender tops along both shut lines. Its underside becomes the envelope's lid.

06 Deliver

A STEP with labelled datums, hardpoints and envelope solids, slim meshes, the hoods in the bay frame, and a hardpoint CSV.



HOOD ON Hood B placed back on (see-through) over the free space.

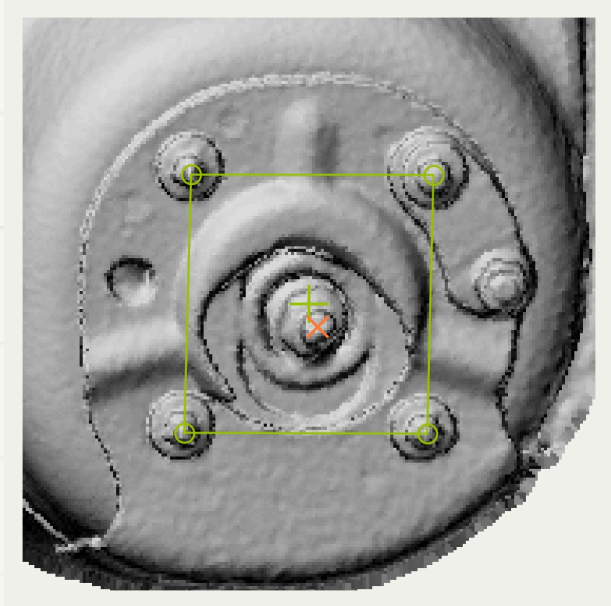
03 Datums you can find again

measured, then confirmed on the car

A packaging reference is only useful if the person holding the tape measure lands on the same zero. So every datum is a physical feature, checked against something independent.

DATUM	DEFINED BY	CHECK
Centreline	The bay's mirror plane	mounts 0.7 mm off
Height zero	Both frame-rail tops	1.45 mm RMS · level ✓
Fore-aft zero	Strut-mount stud patterns	sides agree 1.0 mm
Handedness	Booster pocket, driver side	LHD ✓

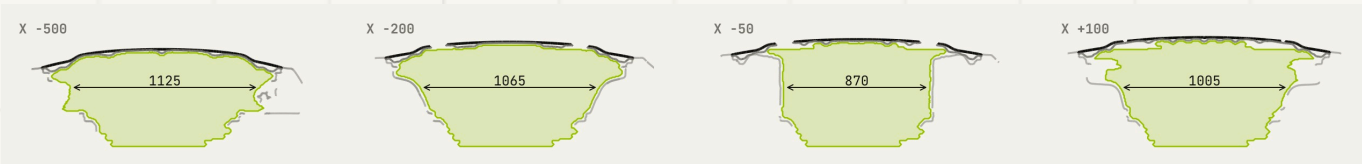
The strut top isn't the datum. Adjustable camber plates put the strut shafts 7.6 mm and 12.9 mm inboard of their mounts, and the two sides differ. The datum is the stud pattern, which doesn't move.



STRUT MOUNT Four-stud pattern and its centre (+). The strut shaft (x) sits off-centre, set by the camber plate.

04 The space that's left

envelope · conservative by design



SECTIONS Looking rearward at four stations. Grey = bay, black = hood skin and inner panel, green = free space. Widths in mm, 200 mm above the rails.

- Kept 10 mm off every scanned surface and off the hood's underside.
- Scan holes are bridged, never left open. About a quarter of the side walls are bridged, and mapped.
- Front stops at the core support. A one-line switch opens the radiator opening (+30 L).
- Delivered as solid slices in the STEP, ready for interference checks.

ENVELOPE	LITRES
Under hood B (stock shape)	518
Under hood A (dome + scoops)	537
Rev 1, assumed flat lid	486
Narrowest width between towers, 100–200 mm up	865 mm

05 Putting the hood back

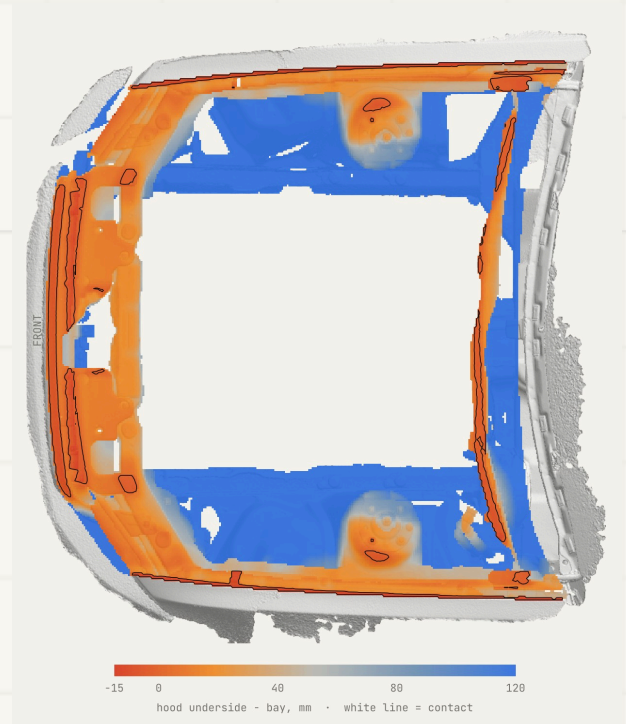
registration · cross-checked

The hoods were scanned off the car; the bay was scanned without one. What connects them is the shut line: a closed hood sits flush with the fenders along both sides. Fitting hood B's edge to the fender tops gives its height, pitch and fore-aft position.

CHECK	RESULT
Shut-line fit, both sides	0.45 mm RMS
Front half vs rear half, fitted separately	within 1.3 mm
Hood A, placed only via the shared crown	0.48 mm median
Hood latch over the bay's latch pocket	✓

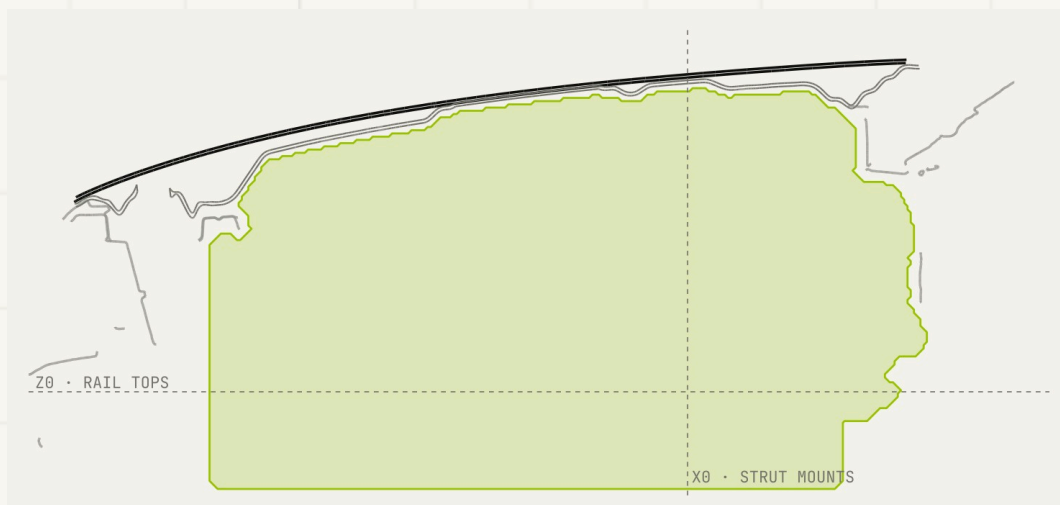


ONE ANSWER Fit error as the hood slides fore and aft: one clear minimum.



CLEARANCE Hood B's underside down to the bay, front to the left. Orange is tight, blue is open; outlines mark where the hood bears on the car.

The bay answered a question the hoods couldn't. Case study 01 flagged hood A's underside height as unmeasurable from its own scans. On the bay, the contact lines put it 16 mm higher, and the scan's skin depth with a 3 mm laminate says 15 mm. Two independent routes, 1 mm apart.



CENTRELINE Front to the left. The hood is the lid: the envelope follows its inner panel from the core support back to the firewall.

06 Where AI-CAD broke

15 failure modes · 1 part · 38 across the lab

BY KIND

Data & evidence		10
Free-space algorithm		3
Tooling		2

BY STATUS

Fixed		8
Worked around		1
Owner confirmed		2
Flagged		2
Still open		2

01 A good fit can sit at the wrong answer.

The first hood fit converged cleanly, 80 mm from the truth; its scoring quietly rewarded staying on the data. A second check caught it: the latch landed 90 mm behind the latch pocket.

02 Silent tools are the dangerous ones.

A standard mesh-slicing call returned almost nothing on a 5.6M-triangle scan, with no error. Only near-blank plots gave it away.

03 The tallest feature isn't the datum.

The first strut-mount search grabbed the wrong surface, then the wrong studs. The fix: look for the shape a designer would use, a four-stud rectangle.

04 Rays lie where scans have holes.

Rays leaked into wheel wells, were shadowed by towers, and read the firewall edge-on as a side wall. Each fix is now a rule, and every bridged wall is mapped.

05 A shared reference beats more fitting.

Two scans of one hood can't give its thickness. Put both on the same car and the car becomes the shared surface: two estimates, 1 mm apart.

STILL OPEN

- ☐ Hood placement assumes it sits flush with the fenders. A straightedge confirms it.
- ☐ Hood B's inner panel overlaps by ~6 mm where it rests: thinner laminate or seal compression. One caliper reading.
- ☐ Nothing below the rails near the centreline was scanned, so the floor is assumed.

SCORECARD · AGENT SELF-SCORES

PART	ACC.	INTENT	EDIT	MFG.
Hood A	3	4	3	4
Hood B	3	3	3	4
Engine bay	4	3	4	n/a

REFERENCE STEP

ENVELOPE SOLIDS

HOODS IN BAY FRAME

HARDPOINT CSV

CLEARANCE MAPS

SCRIPTS

**Know the space
before you fill it.**

3D SCANNING · REVERSE ENGINEERING · PRODUCTION CAD

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