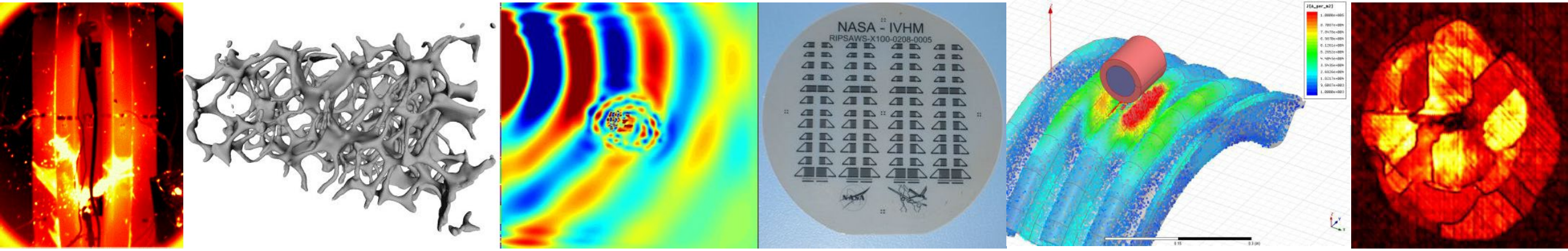


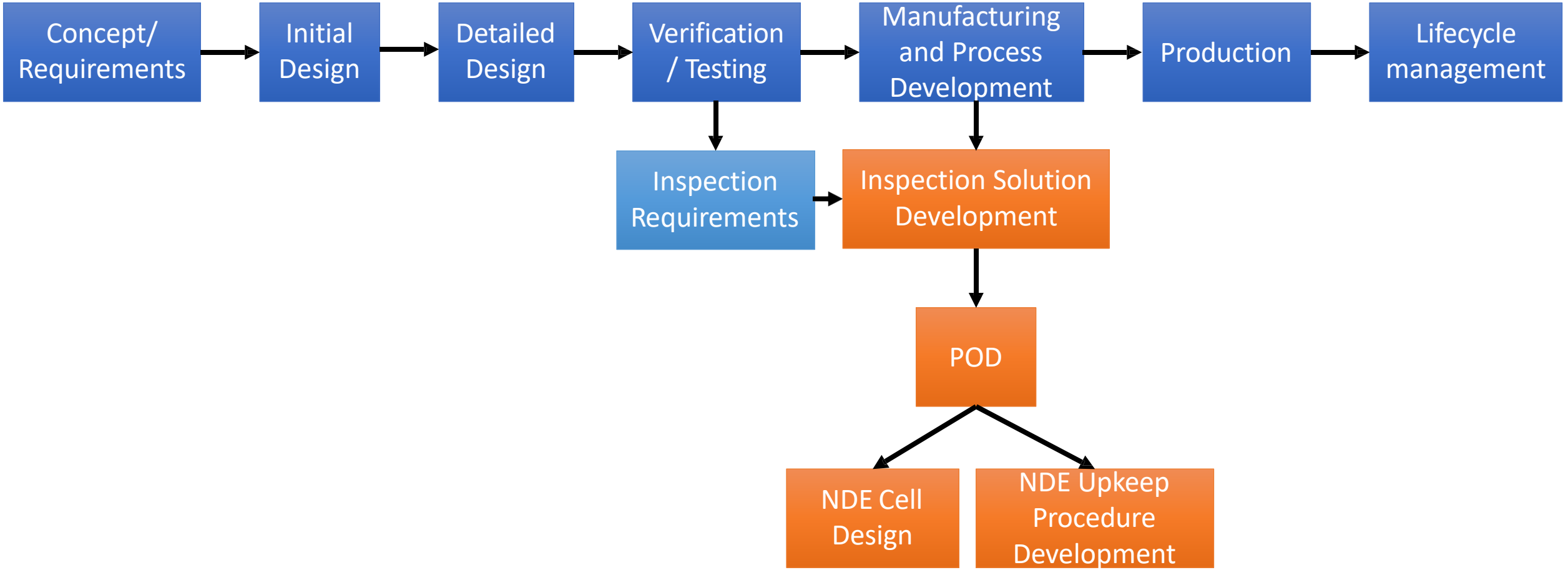
NESB
Nondestructive Evaluation Sciences Branch

The Inspectability Metric: A Formalized System of Measurement Enabling the Design for Inspection Framework

Peter Juarez, Bastien Clausse, Starr D'Auria, Jérôme Dudous, Elizabeth Gregory, Sébastien Lonné, August Noevere, Bill Schneck

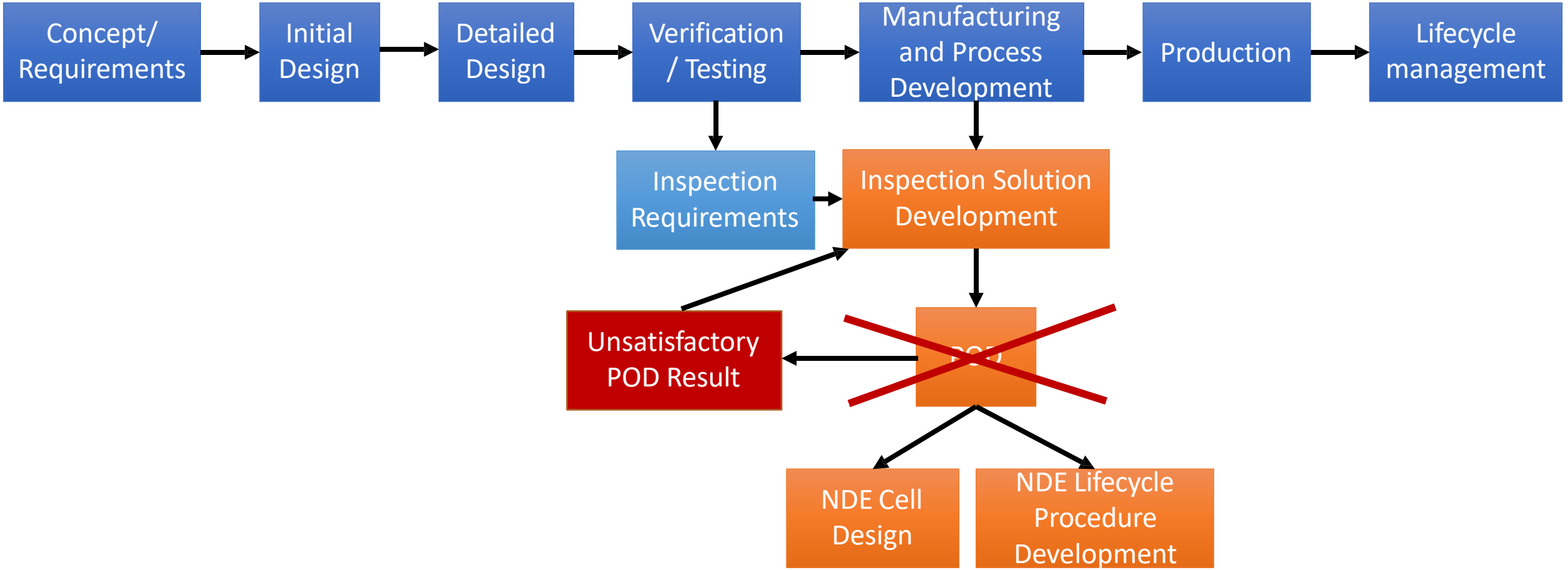
Current aerospace design workflow

Current aerospace design workflow

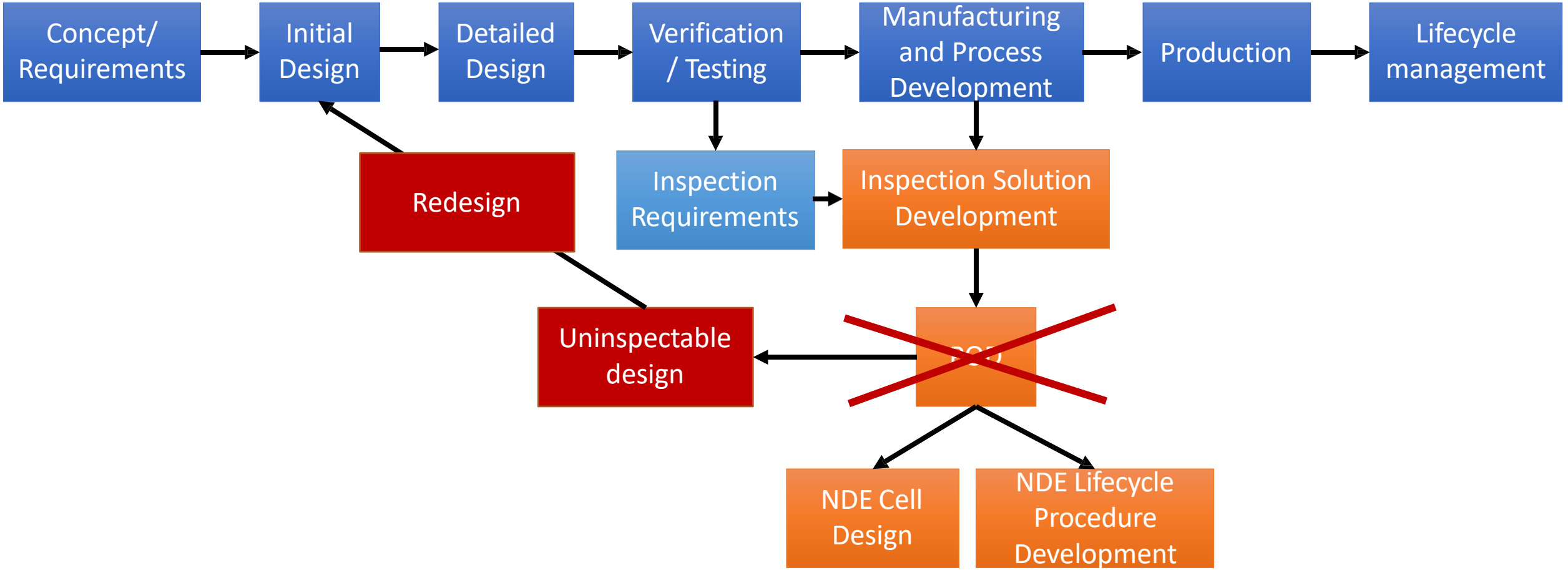


NDE: Nondestructive Evaluation

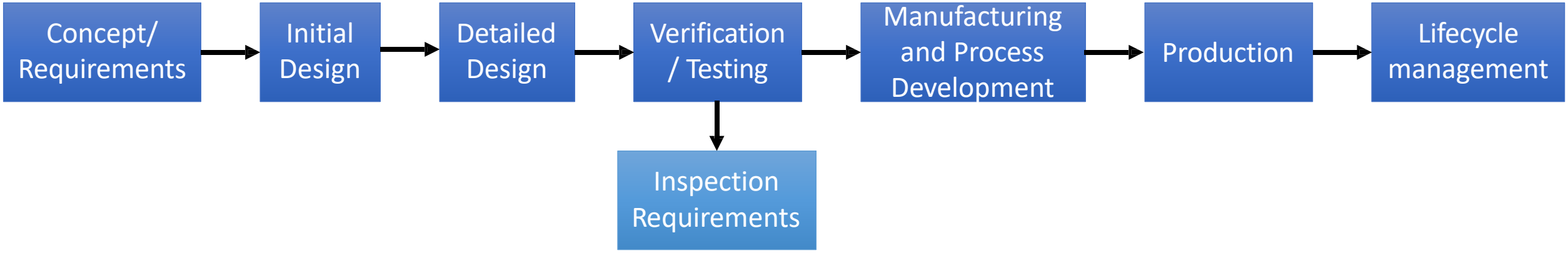
POD: Probability Of Detection


Concept/ Requirements
Initial Design
Detailed Design
Verification / Testing
Manufacturing and Process Development
Production
Lifecycle management
Inspection Requirements
Inspection Solution Development
Unsatisfactory POD Result
NDE Cell Design
NDE Lifecycle Procedure Development

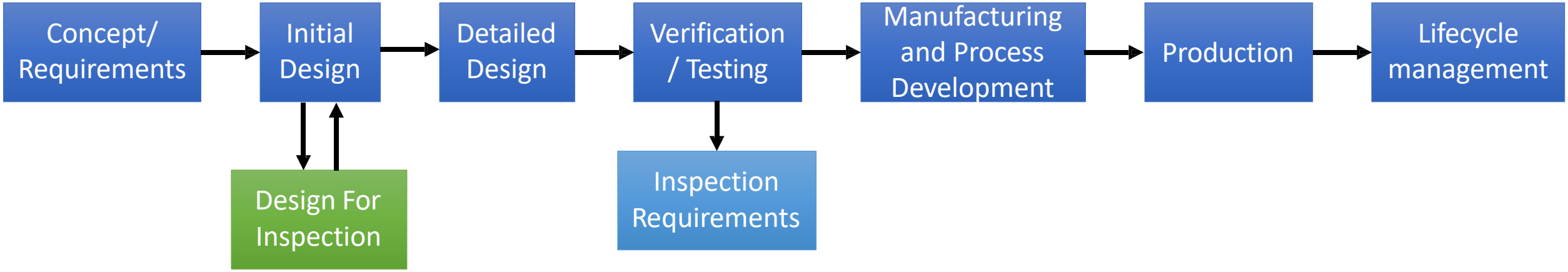
Current aerospace design workflow



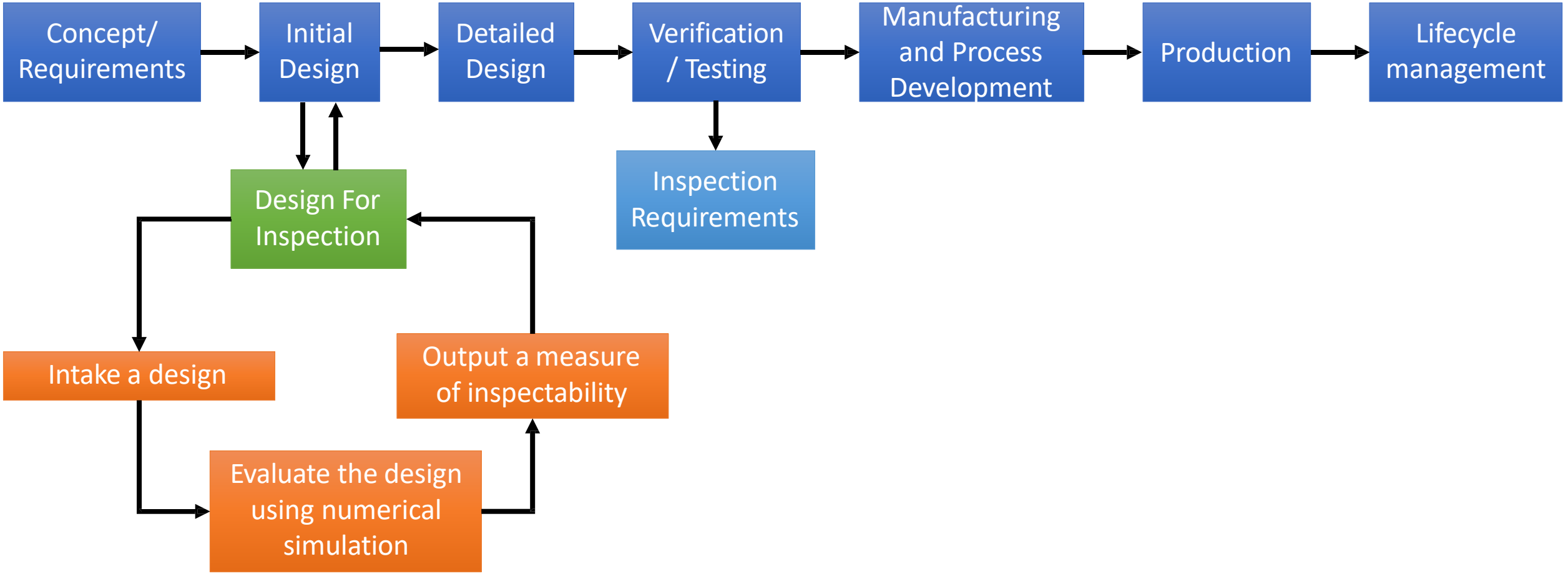
Integrating NDE simulation to workflows



Integrating NDE simulation to workflows



Integrating NDE simulation to workflows



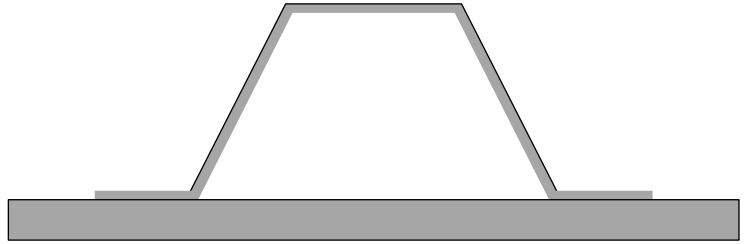
Design for Inspection (DFI) framework

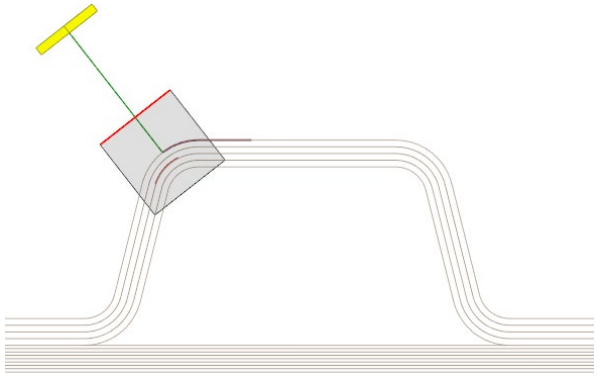
Inspectability metric

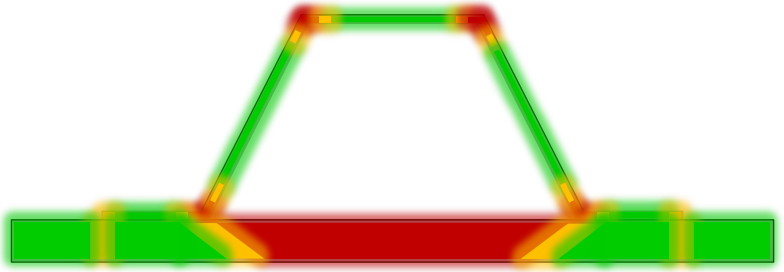
Intake a design

Evaluate the design using numerical simulation

Output a measure of inspectability







The question DFI is trying to answer

~~How well can we find a defect?~~

How does the design change the physics of detecting a defect?

Evaluating Inspectability of Competing Designs

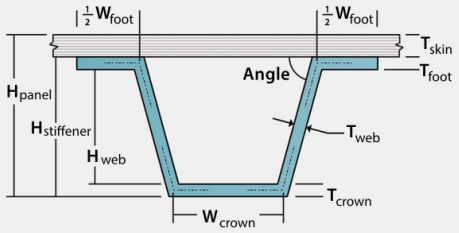
Zone 4950 - "C10"

Name: 4950 - "C10"

Design: Hat Bonded - 2

Concept: Hat Bonded

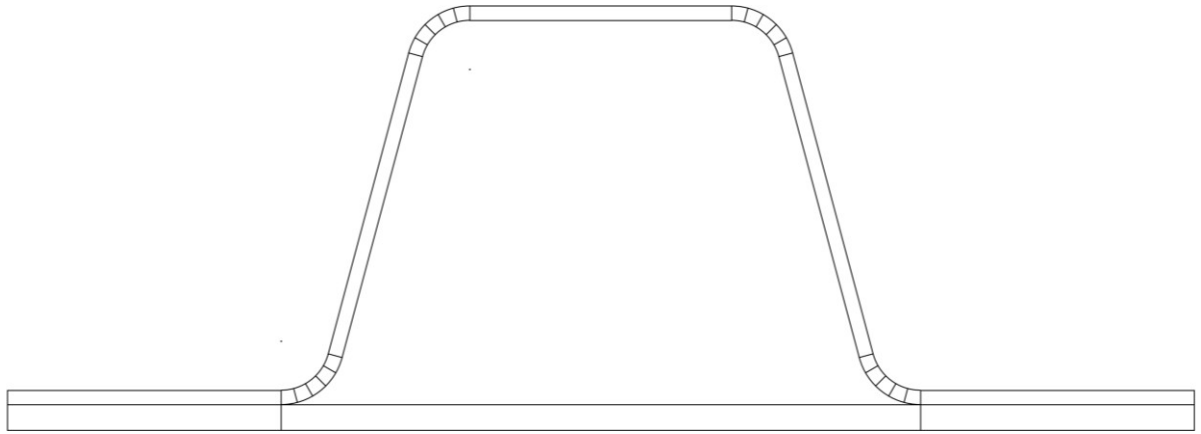
Show Inputs | All Designs

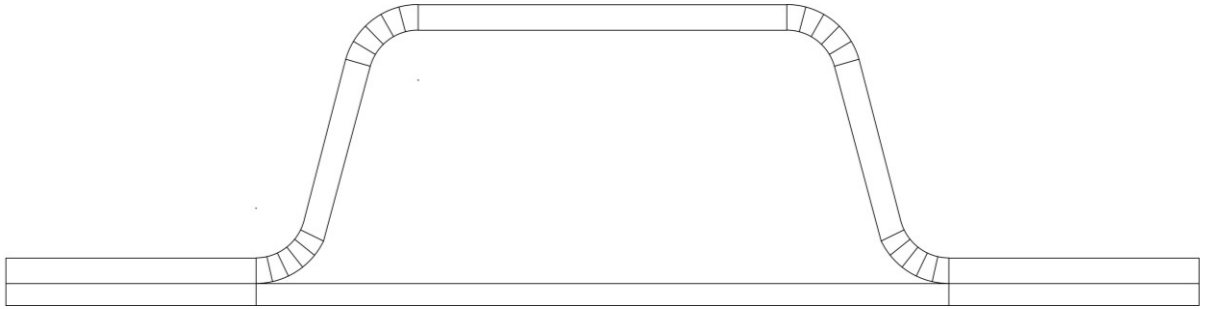


Dimension	Result	0/45/90 %	0/45/90 #	Plies	Material
T_{skin} (in)	0.044	25/50/25	2/4/2	8	DL: LF Skin - 2, 1, 8 plies
T_{web} (in)	0.088	25/50/25	4/8/4	16	DL: LF Stiffener - 2, 11, 17 plies
T_{foot} (in)	0.088	25/50/25	4/8/4	16	DL: LF Stiffener - 2, 11, 17 plies
T_{crown} (in)	0.0935	29/47/24	5/8/4	17	DL: LF Stiffener - 2, 11, 17 plies
$H_{stiffener}$ (in)	0.86				
Spacing (in)	3.3151				
Angle (°)	65				
W_{foot} (in)	1				

Close

COLLIER HYPERX AEROSPACE SOFTWARE

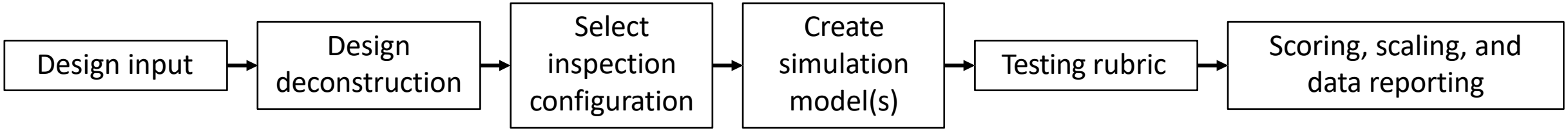




Two hat stiffener designs generated by HyperX

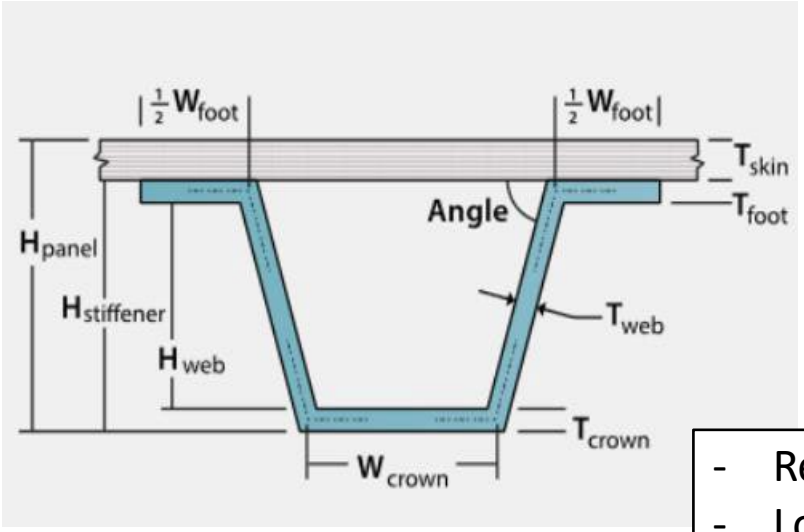
Inspectability Metric Overview

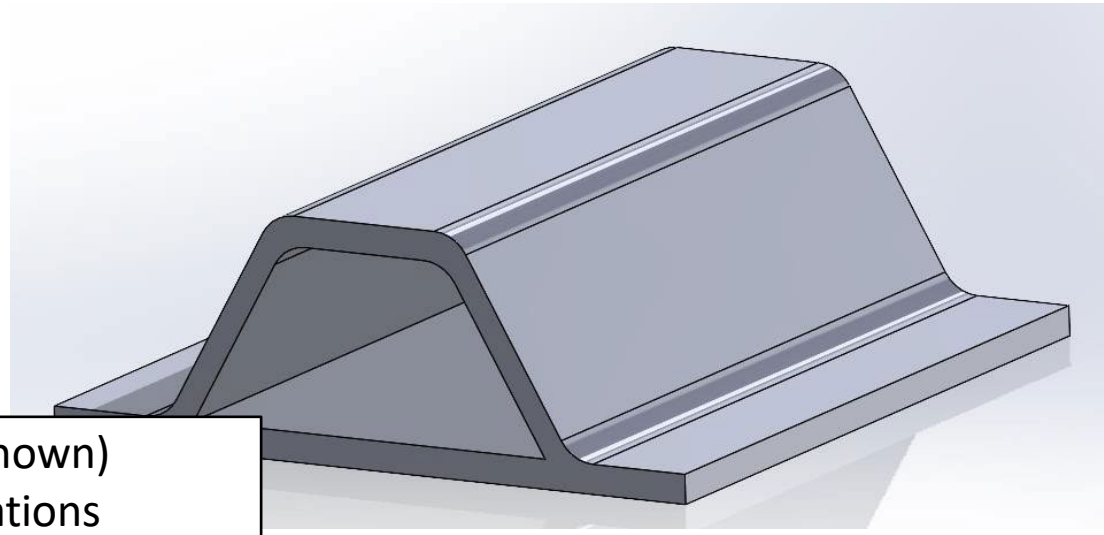
Inspectability metric overview



Inspectability metric overview

Design input → Design deconstruction → Select inspection configuration → Create simulation model(s) → Testing rubric → Scoring, scaling, and data reporting

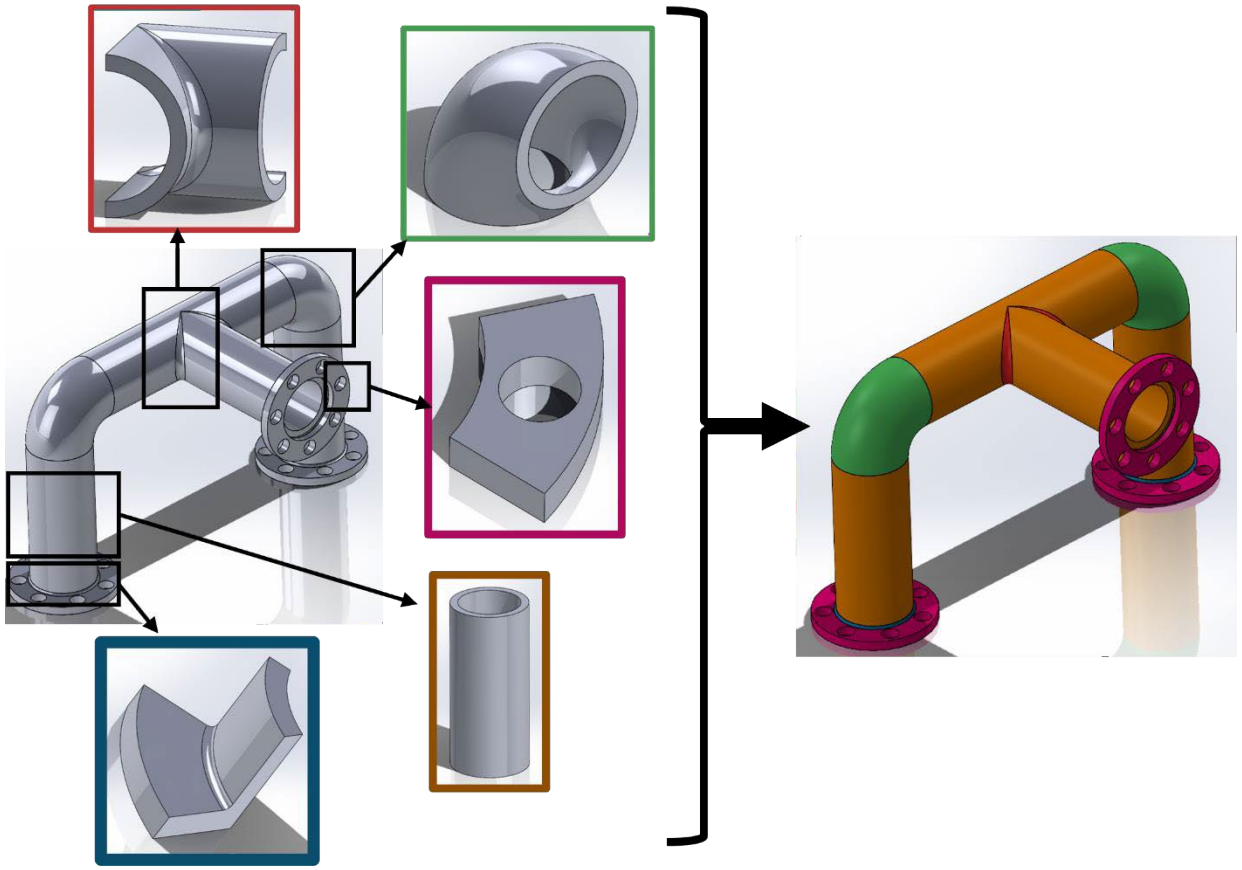


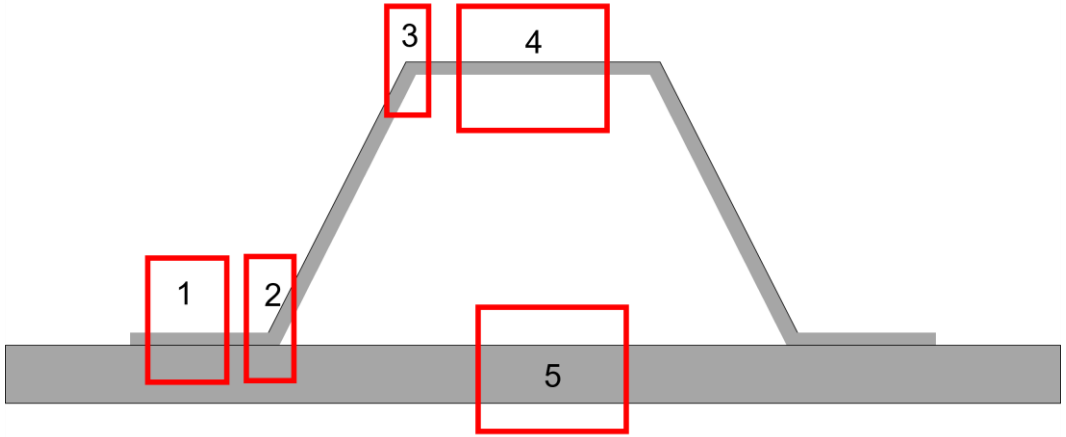


- Requirements (if known)
- Logistical considerations (accessible surfaces, clearance)
- Material properties
- Etc.

Inspectability metric overview

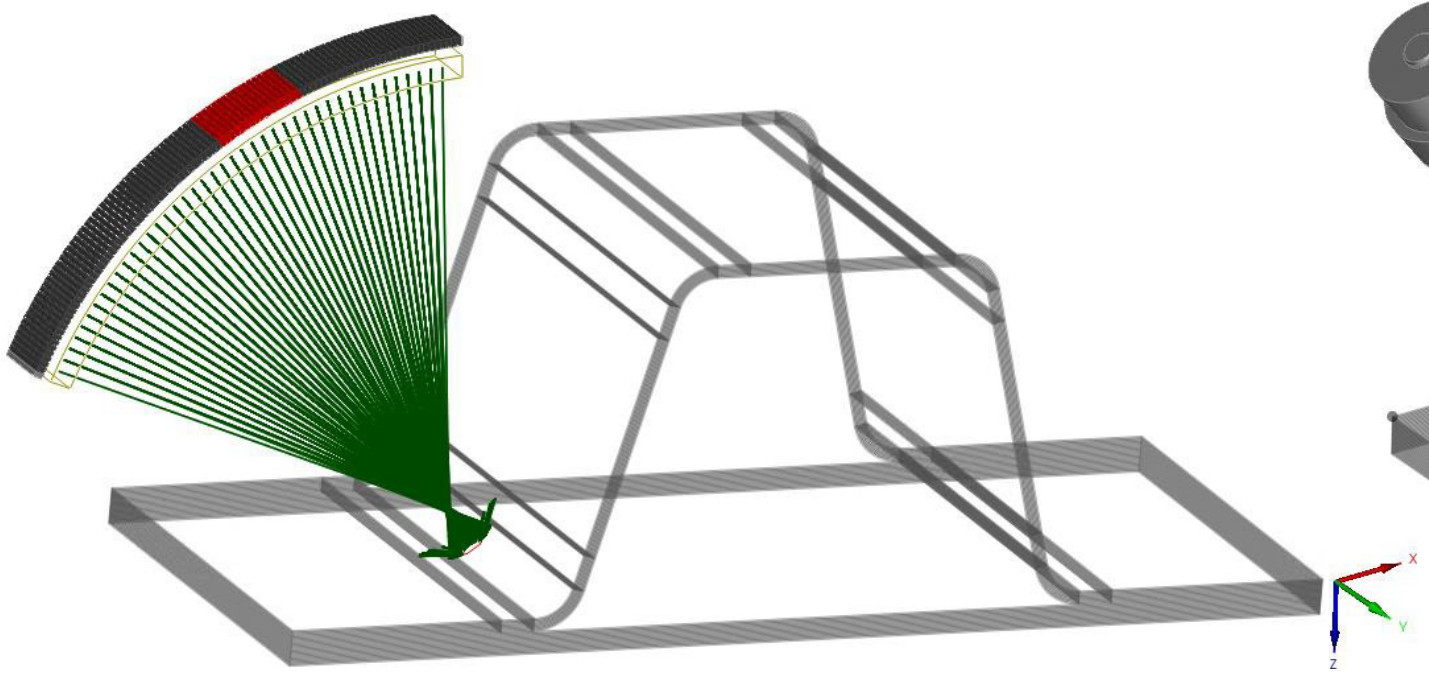
Design input → **Design deconstruction** → Select inspection configuration → Create simulation model(s) → Testing rubric → Scoring, scaling, and data reporting

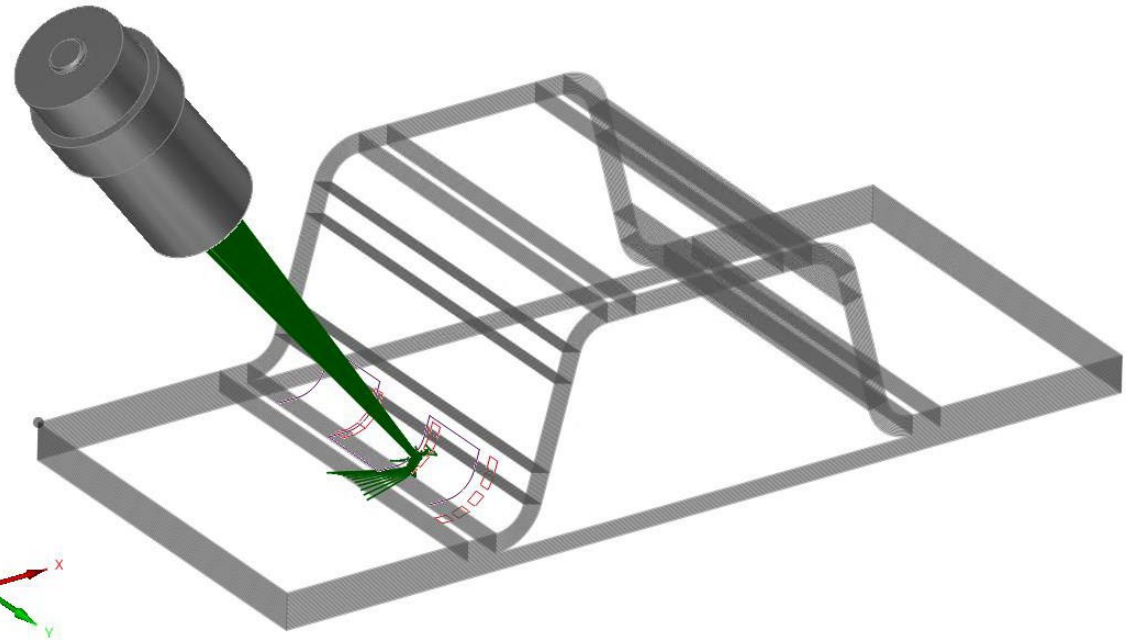




Inspectability metric overview

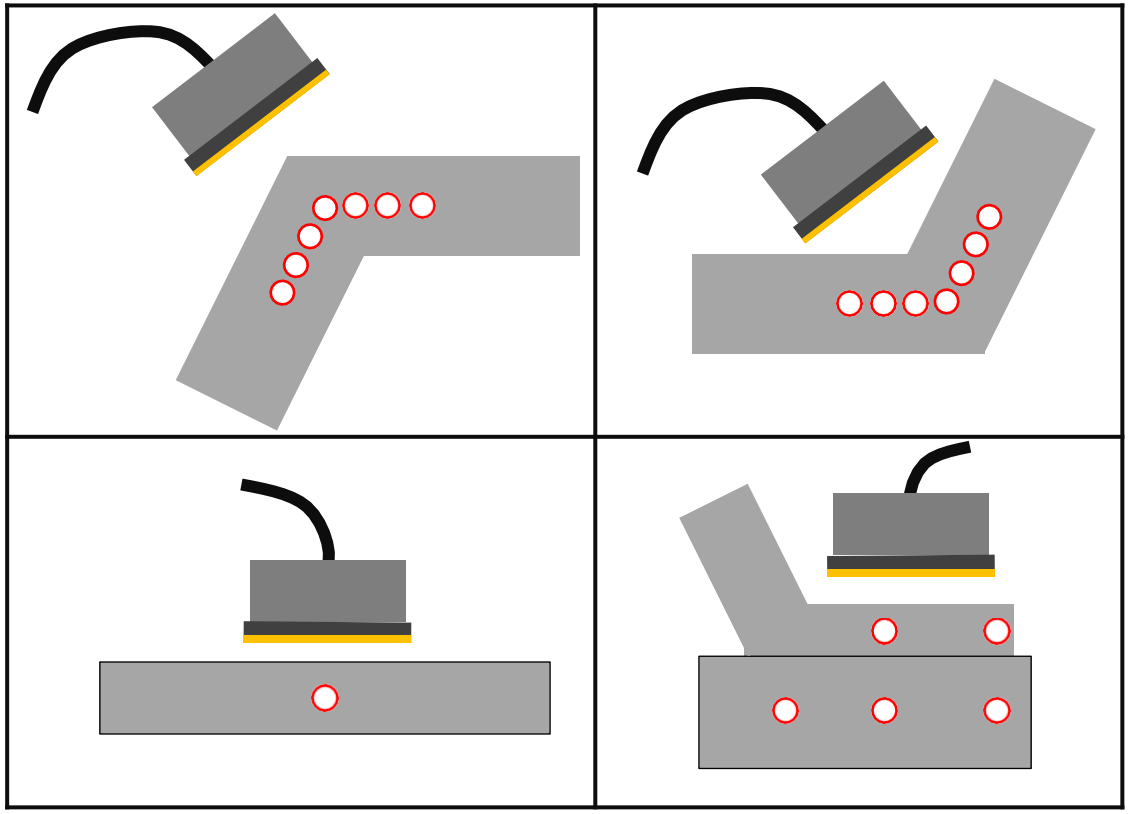
Design input → Design deconstruction → **Select inspection configuration** → Create simulation model(s) → Testing rubric → Scoring, scaling, and data reporting

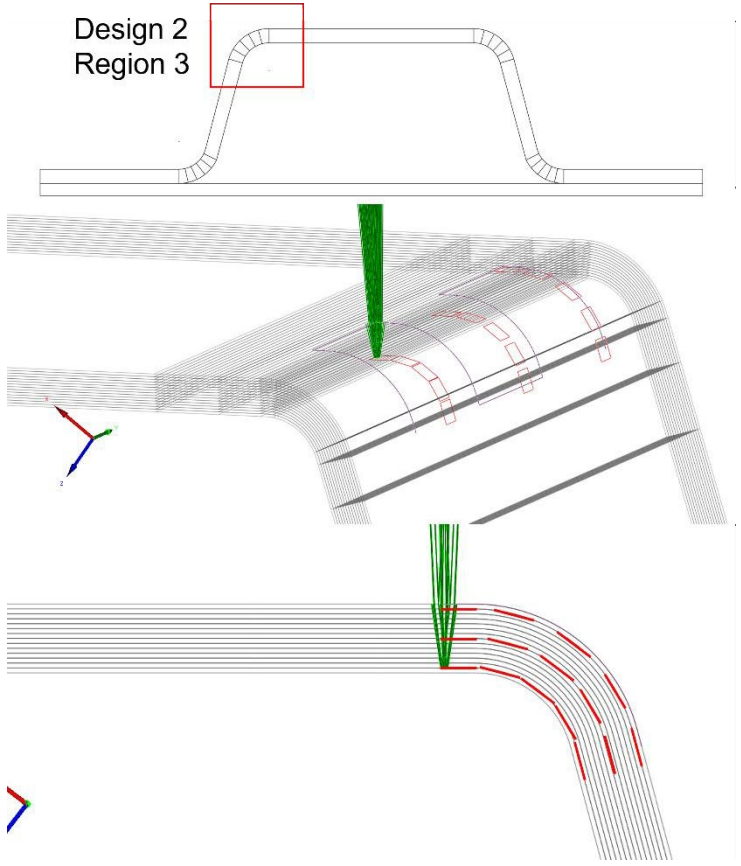




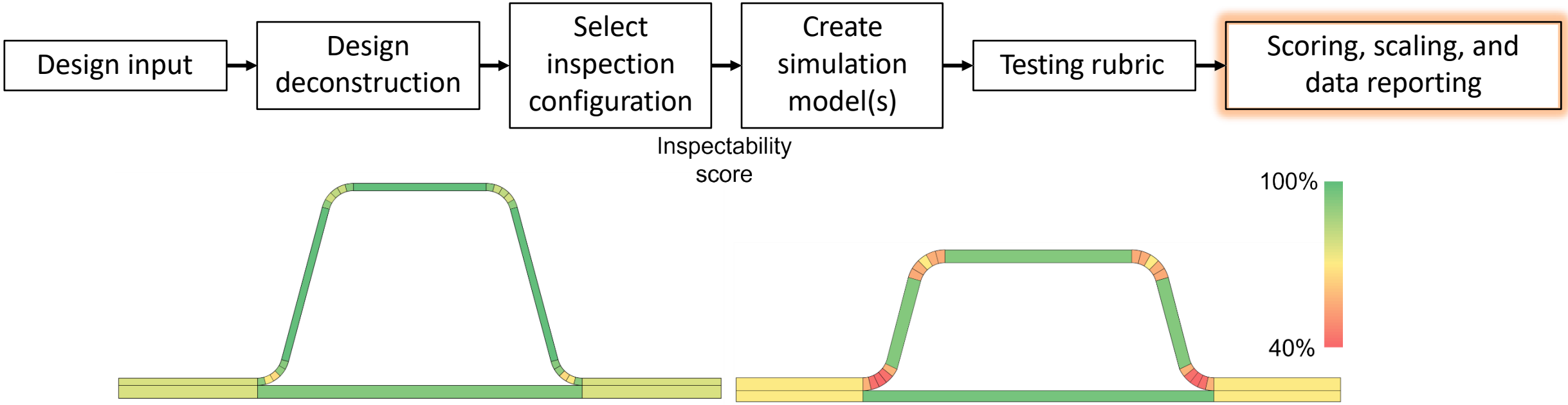
Inspectability metric overview

Design input → Design deconstruction → Select inspection configuration → Create simulation model(s) → Testing rubric → Scoring, scaling, and data reporting





Inspectability metric overview



Inspectability metric overview

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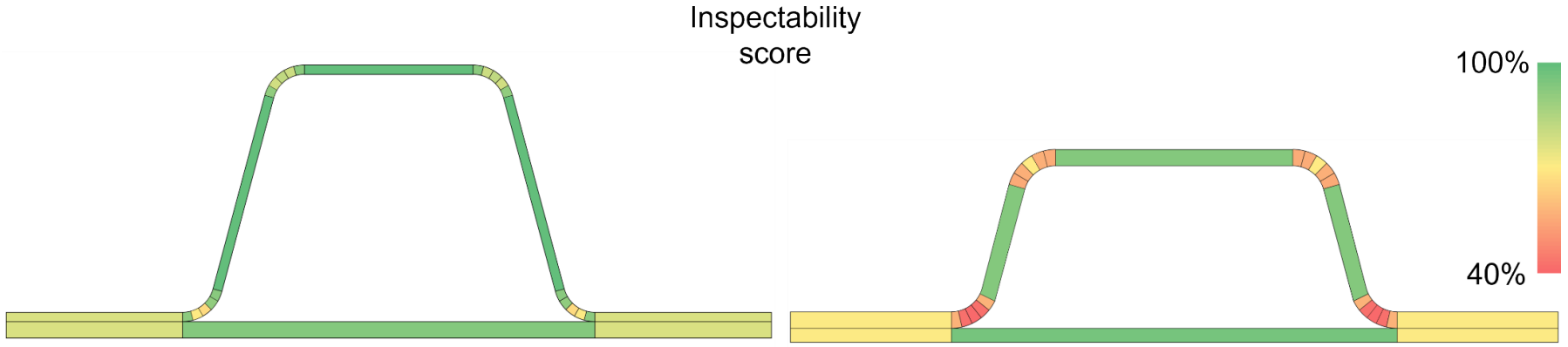
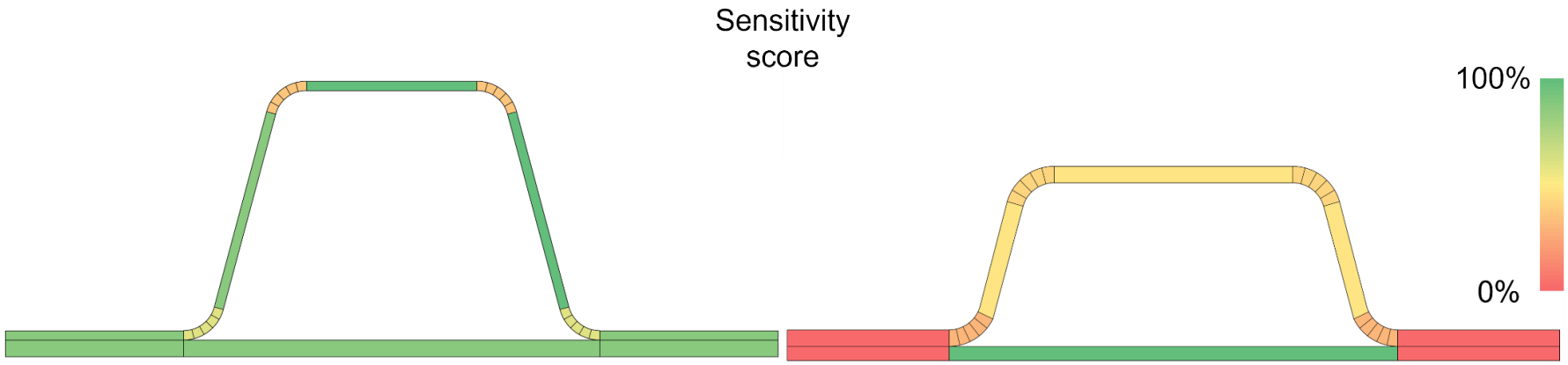
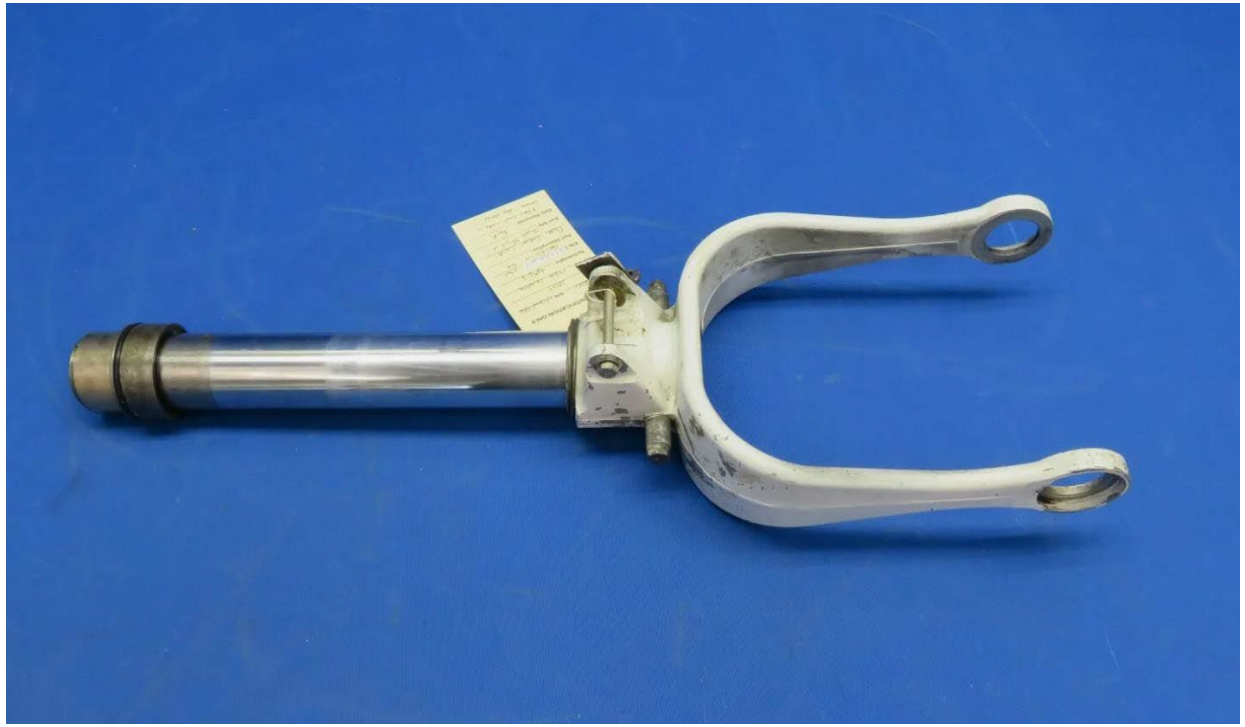




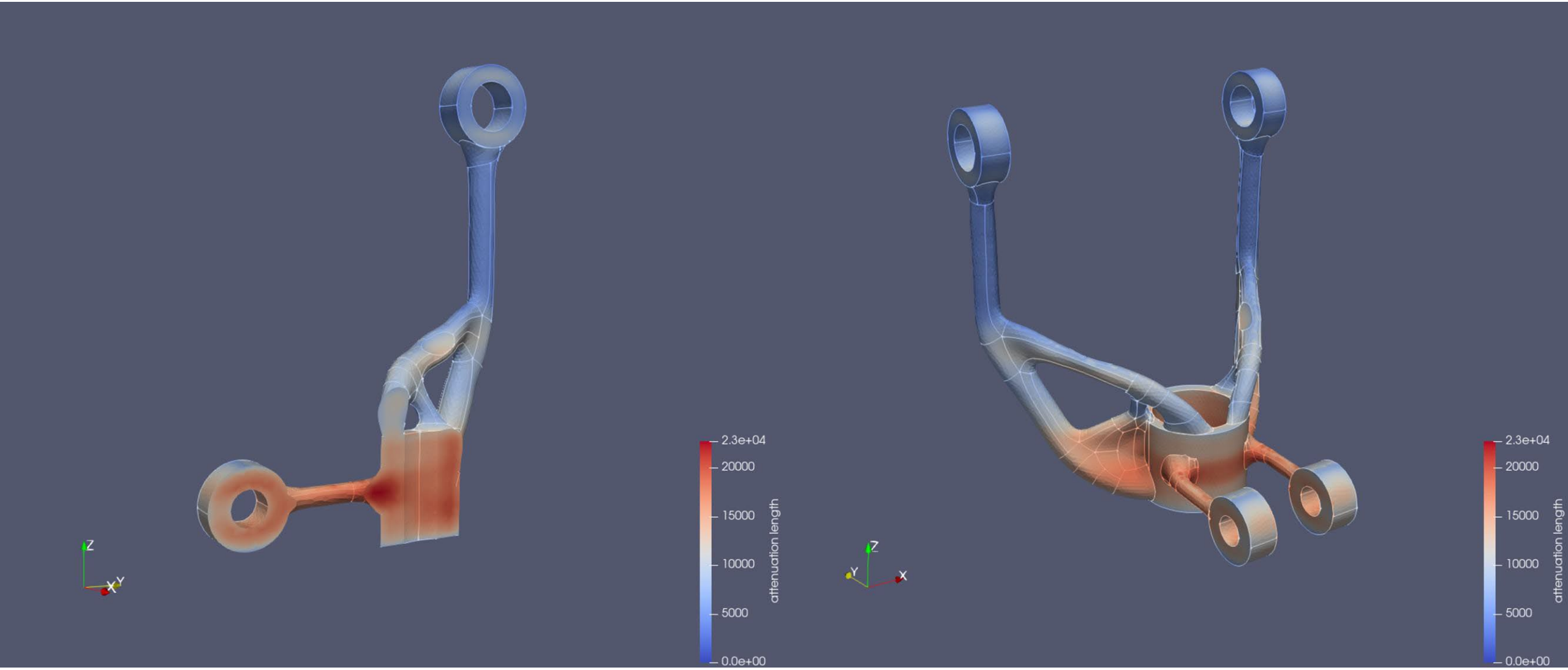
Future work



Cessna landing gear fork

Design created using generative design algorithm in Autodesk Fusion360 generative design algorithm

Future work


2.3e+04
20000
15000
10000
5000
0.0e+00
attenuation length
Z
Y
X
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attenuation length
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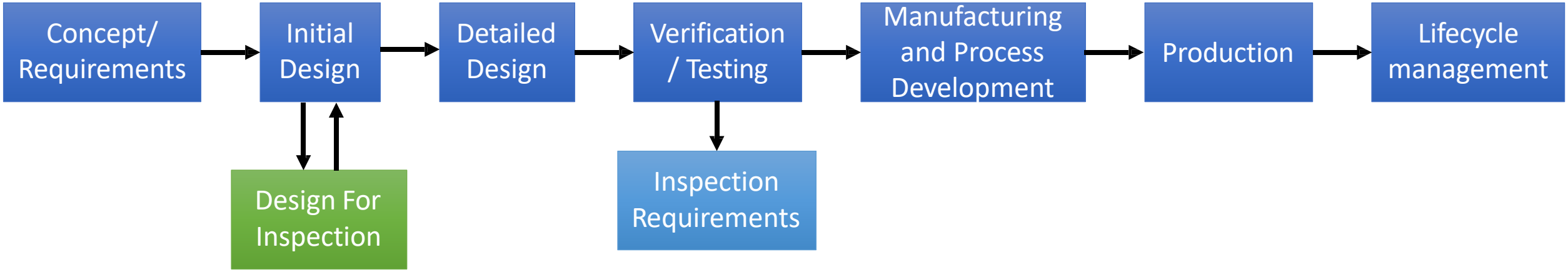
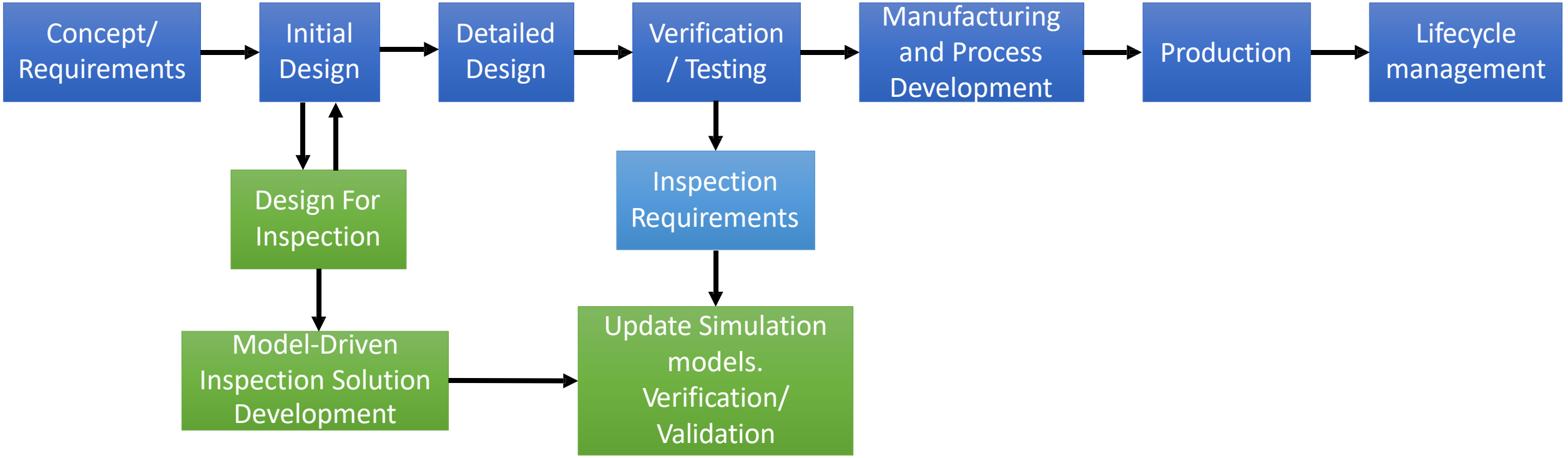
Y
X

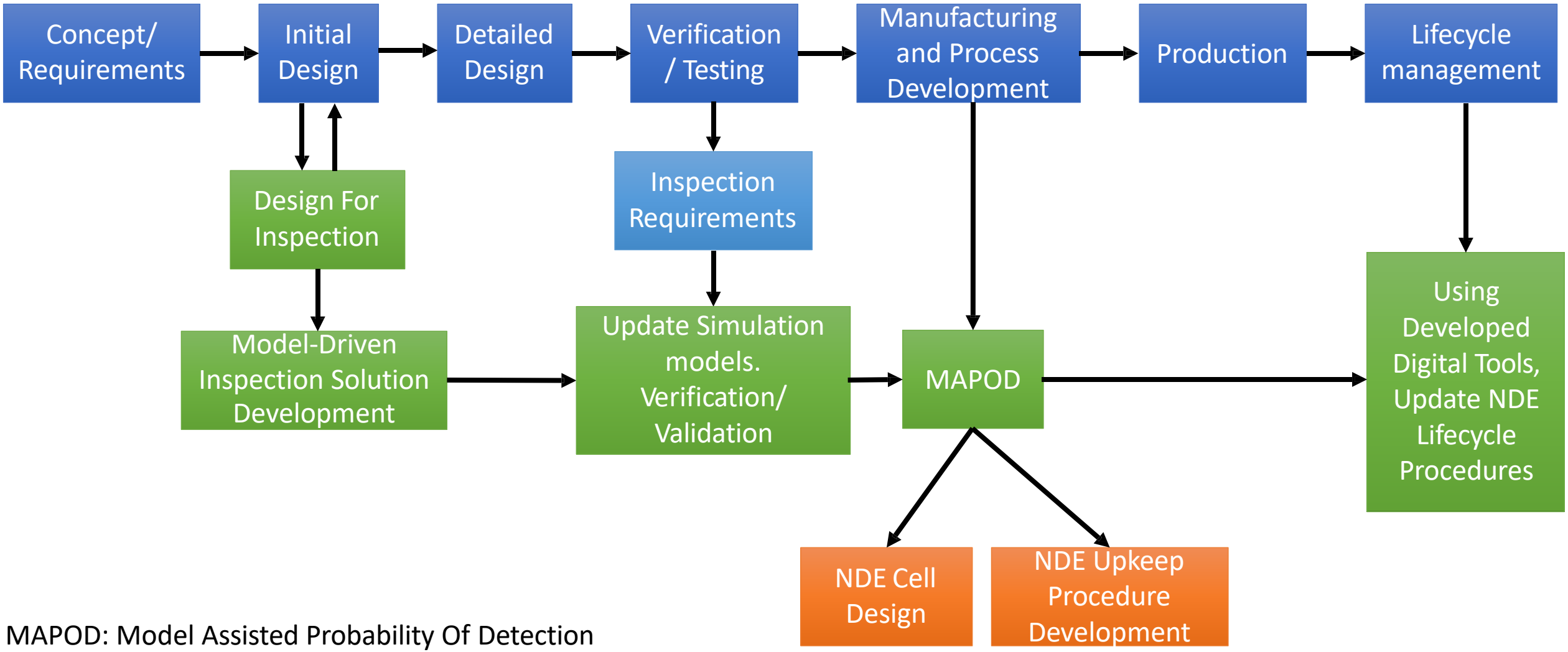
Integrating NDE simulation to workflows



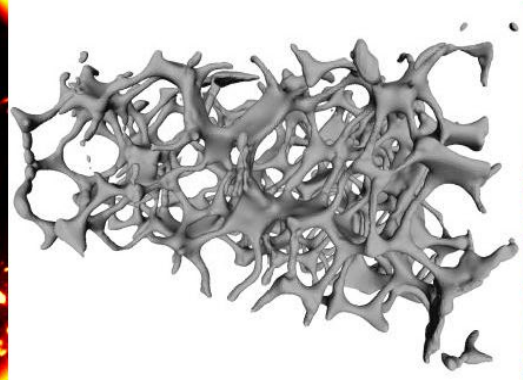
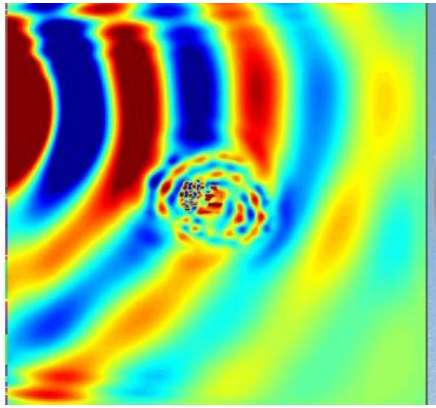
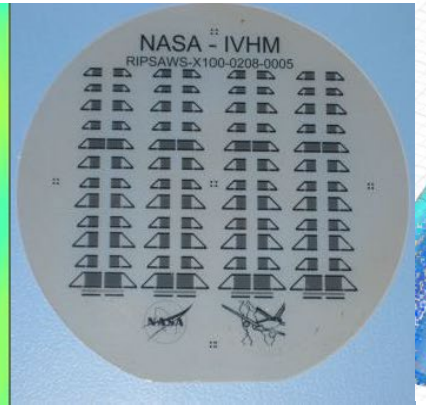
Integrating NDE simulation to workflows

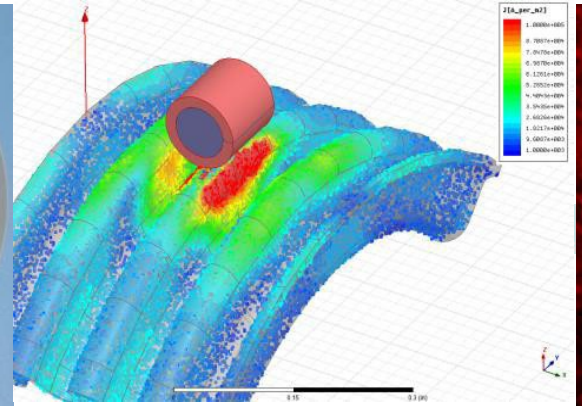
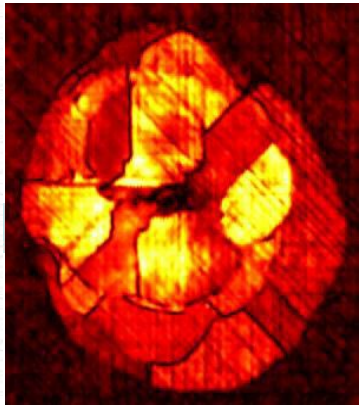


Integrating NDE simulation to workflows



MAPOD: Model Assisted Probability Of Detection

Questions?