Flow to Fiber Orientations: Smarter Gate Placement

Integrating Moldflow Insights into Digimat for Injection Gate Position Analysis

Dustin Souza, Business Development Manager
dsouza@cadence.com

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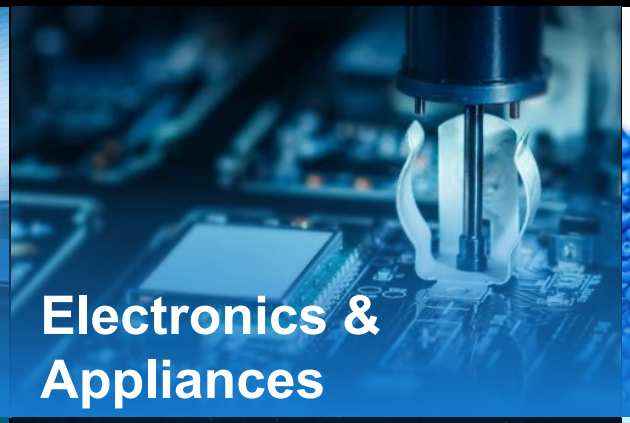
Agenda

- Introduction
- Solutions
- Case Study
- Results
- Conclusions

Introduction

Materials

Heart of any product



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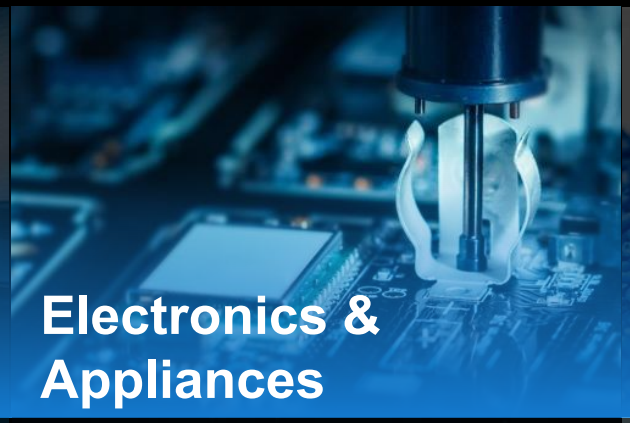

What Drives Companies?

Regulators & Customers

What do they want?

Sustainability

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Sustainability

Regulators & Customers

What do they want?

- **Europe**
  - **ESPR : Regulation (EU) 2024/1781**
    Efficiency, durability, & reduced material mass
  - **CEN-CENELEC : JTC 10**
    Reduced material volume, & part consolidation
  - **RoHS : Directive 2011/65/EU**
    Encourages polymer alternatives
  - **WEEE : Directive 2012/19/EU**
    Recyclability & disassembly
- **International**
  - **IEC : 60335-1 & 60335-2-X**
    Mechanical strength, impact resistance, heat resistance, & electrical insulation
  - **IEC : 60034-30**
    High efficiency, tighter air gaps, & precise structural alignment

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How Do We Meet These Demands?

Sustainability

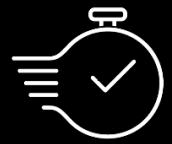
1. Simulation

Strength ⟷ Static

Safety ⟷ Dynamic (drop/impact)

Efficiency ⟷ Material & design optimization

Comfort ⟷ NVH (modal/damping)



Durability ⟷ Fatigue & creep

cadence® Ansys LS-DYNA DASSAULT SYSTEMES SIEMENS

How Do We Meet These Demands?

Sustainability

2. Material Choices

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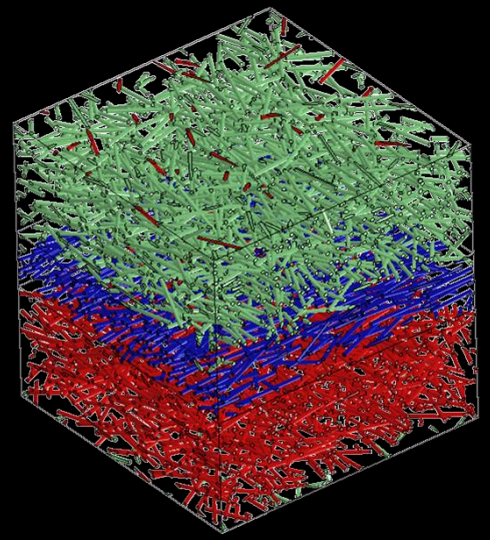
What is a Composite Material?

Any material made up of two, or more, phases

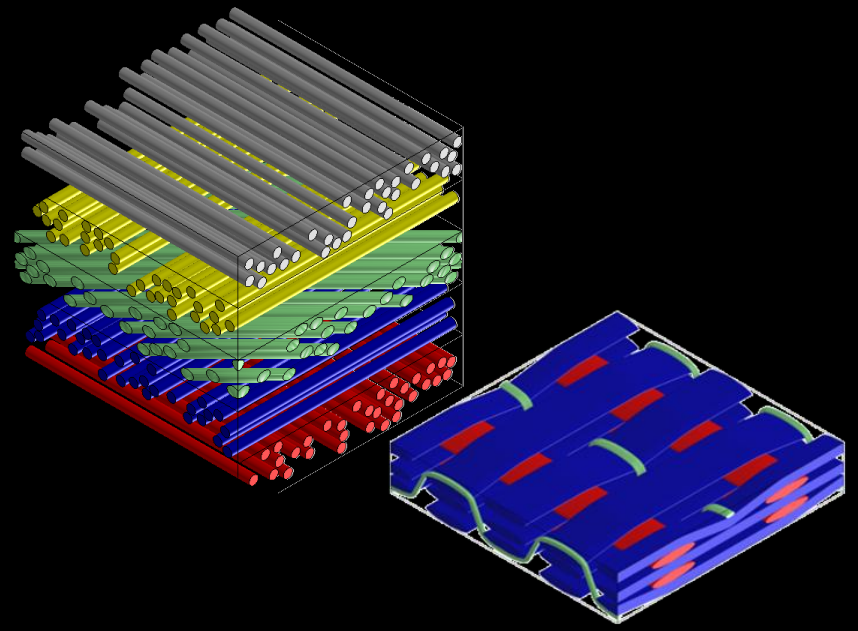
Chopped fiber reinforced plastics

- Short fibers
- Long fibers
- Etc.



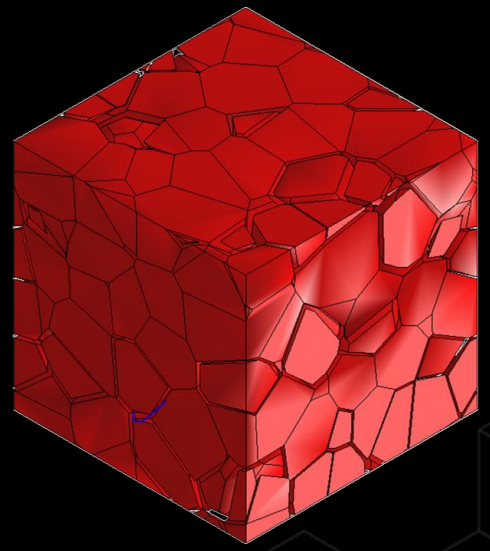
Continuous fiber composites

- Unidirectional
- Woven & braided
- Etc.



Other materials

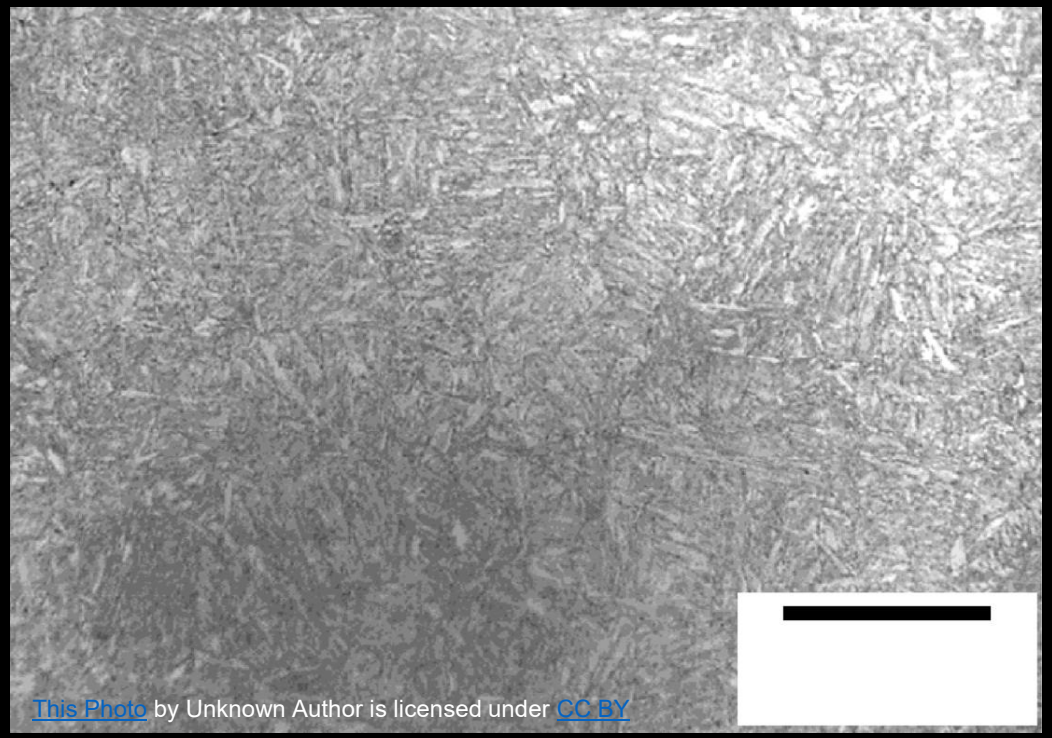
- Cast metals
- Foams
- Etc.



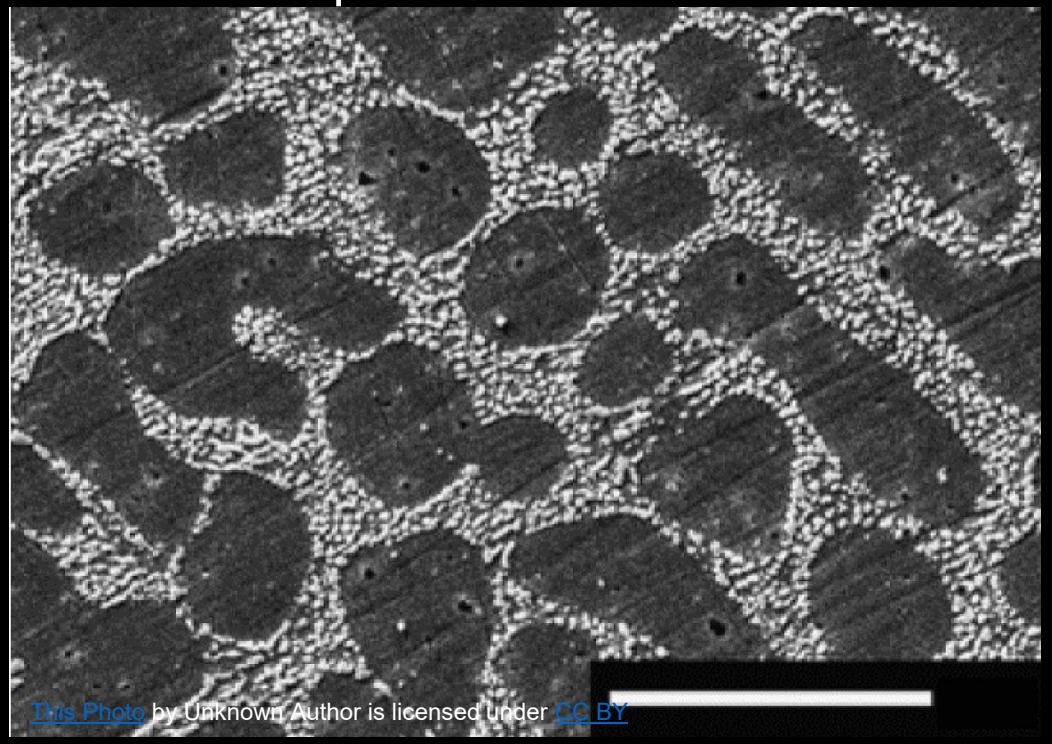
Are Composites More Complex?

Yes, and they require advanced solutions to model accurately

Metal microstructure



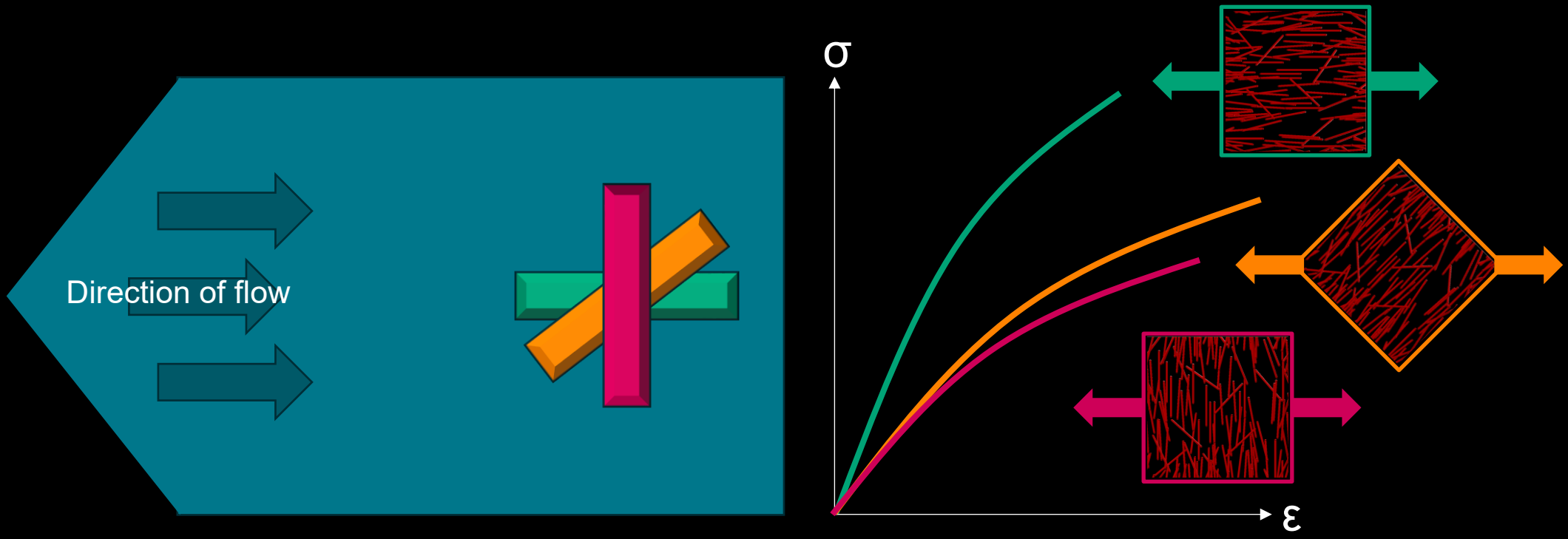
Composite microstructure



What Makes Composites More Complex?

Anisotropy

Directionally dependent stiffness & strength



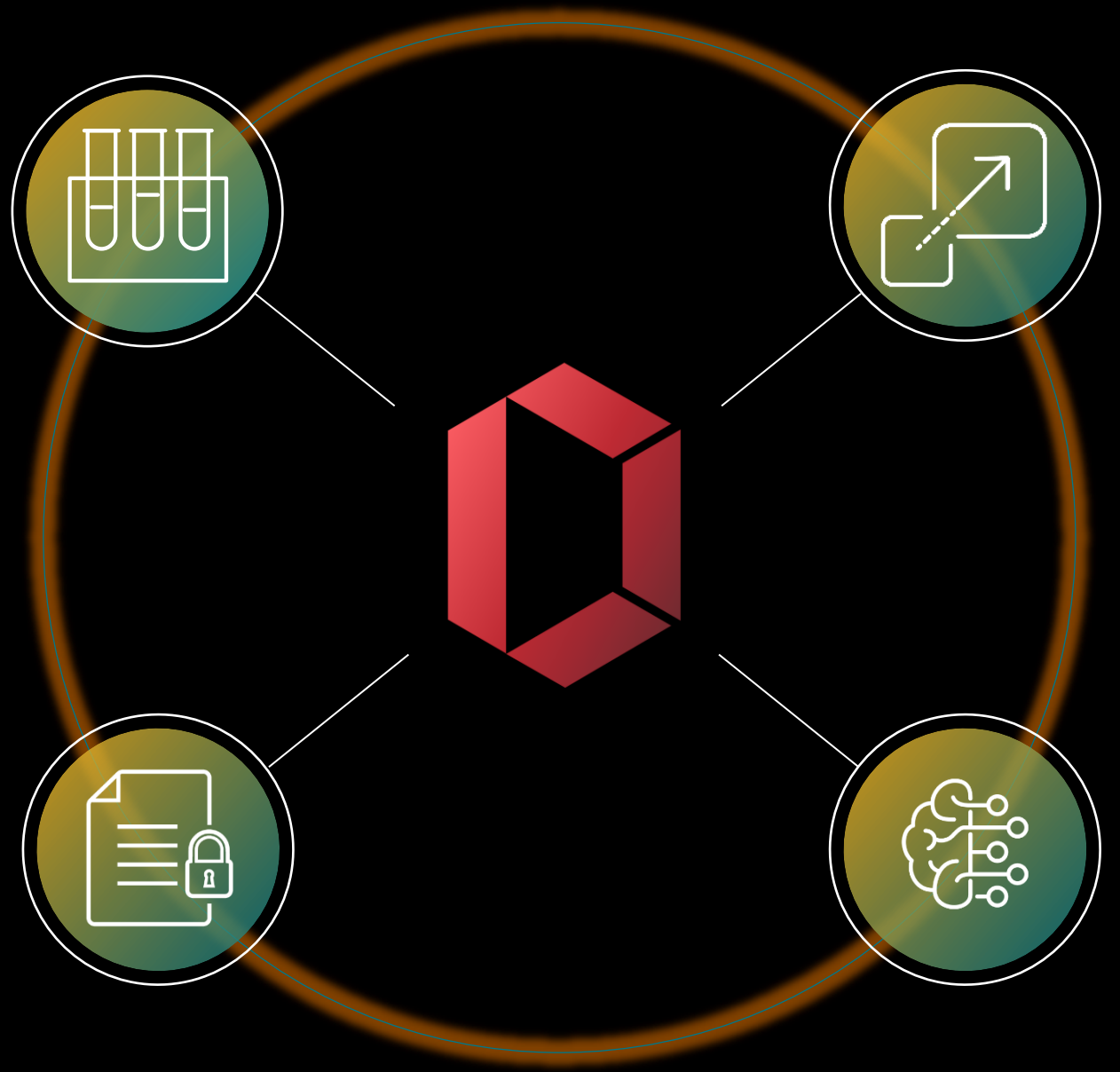
What If We Don’t Capture Anisotropy?

- Over-design
  - Heavier part
  - More material
  - More expensive
  - More resources required

- Under-design
  - Unexpected failure
  - More prototyping
  - More expensive
  - More resources required

Solutions

Which Solution?



Digital Materials Laboratory

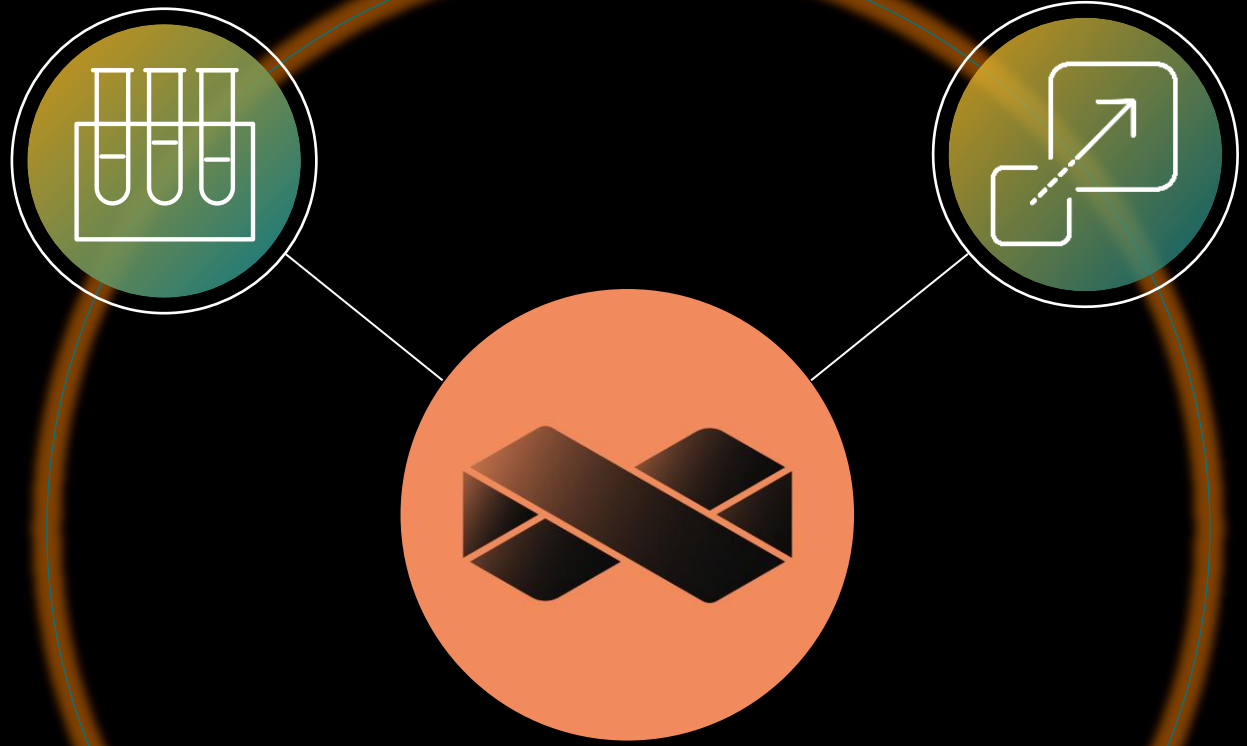
Multiscale Simulations

Material Data Management

Materials Informatics

Which Solution?

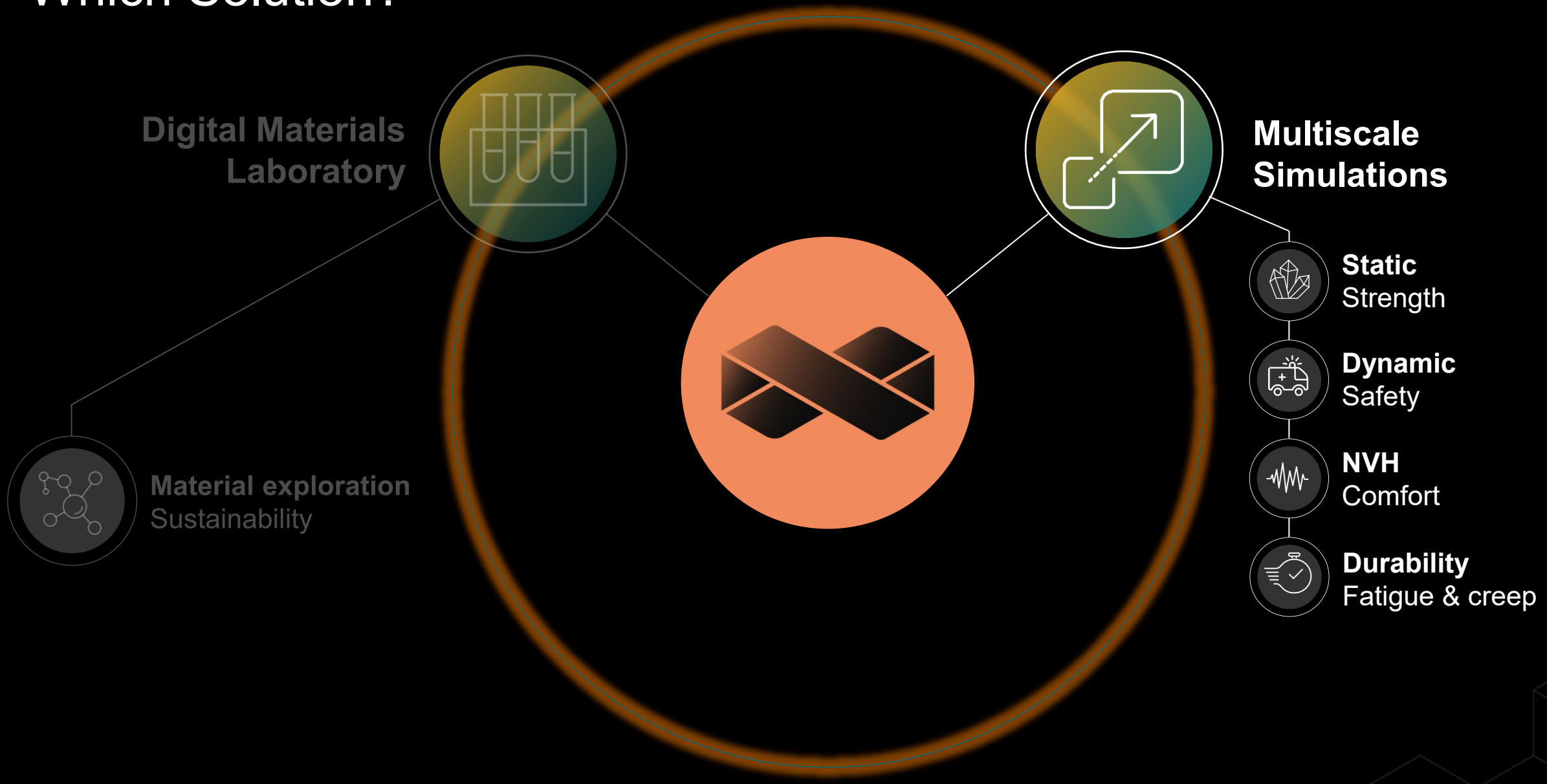
Digital Materials Laboratory



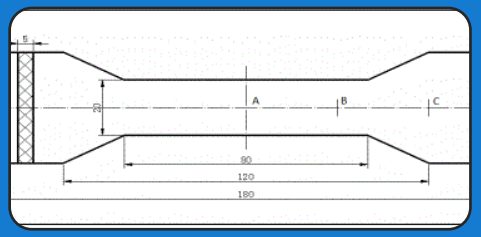
Multiscale Simulations

DigiMaterial

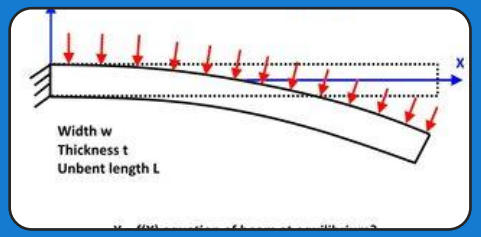
Which Solution?



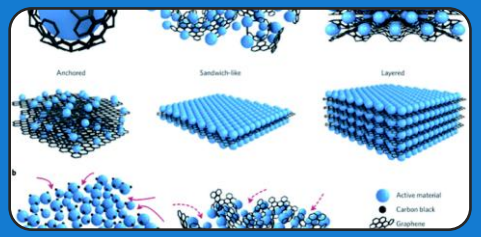
Key Points For Structural Analyses



Geometry

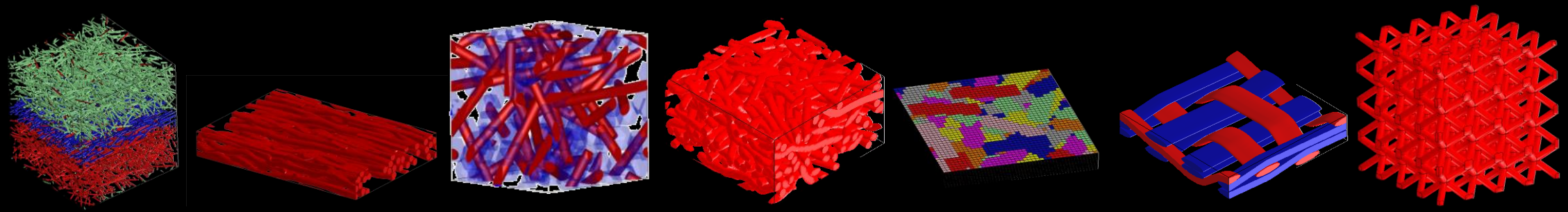


Loading & Fixtures



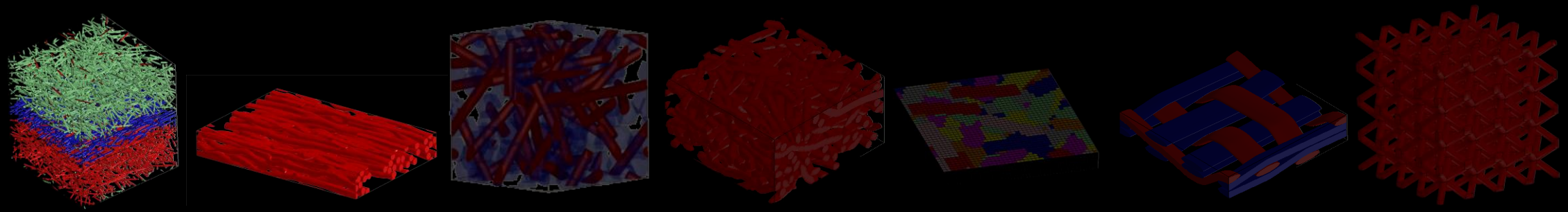
Material Properties

Material Types



SFRP / injection molding	LFRP / injection molding	SFRP / MicroCellular	SMC / Compression molding	DFC / Compression molding	CFRP / Draping, RTM, AFP	Unfilled & reinforced polymer / AM
Fiber orientation	Fiber orientation	Fiber orientation	Fiber orientation	Chip orientation	Fiber orientation	Toolpath
Weld lines	Fiber volume fraction	Porosity volume fraction	Fiber volume fraction	Chip volume fraction	Porosity	Residual stresses
Residual stresses	Fiber length		Weld lines	Chip waviness		
	Weld lines		Fiber waviness			

Material Types



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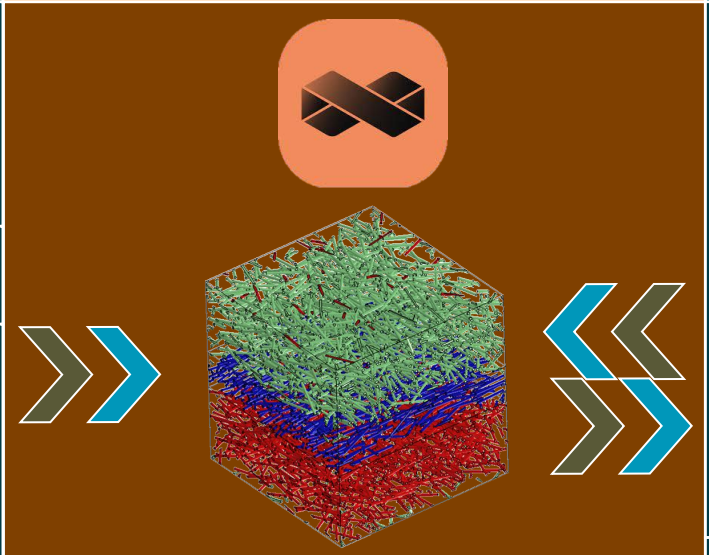
Material Models

Material database

680+ grades

75,000+ material models

Process & Structural Simulation Tools

Process Software	Material Modeling	Structural Analysis Software
Molding: AUTODESK MOLDFLOW, Simpoe, 3D TIMON, Moldex3D, REM3D®	 Digimat	Structural: Marc, MSC Nastran, Ansys / LS-DYNA, DASSAULT SYSTEMES, esi get it right®
Additive: Digimat		
Draping Stamping RTM AFP: DASSAULT SYSTEMES, ANIFORM VIRTUAL FORMING, esi get it right®, Vericut, CORIOLIS		
CT Scan: VOLUME GRAPHICS		Fatigue: CAEfatigue, nCode
Metal Casting: esi get it right®, MAGMASOFT® autonomous engineering		

Case Study

Case Study

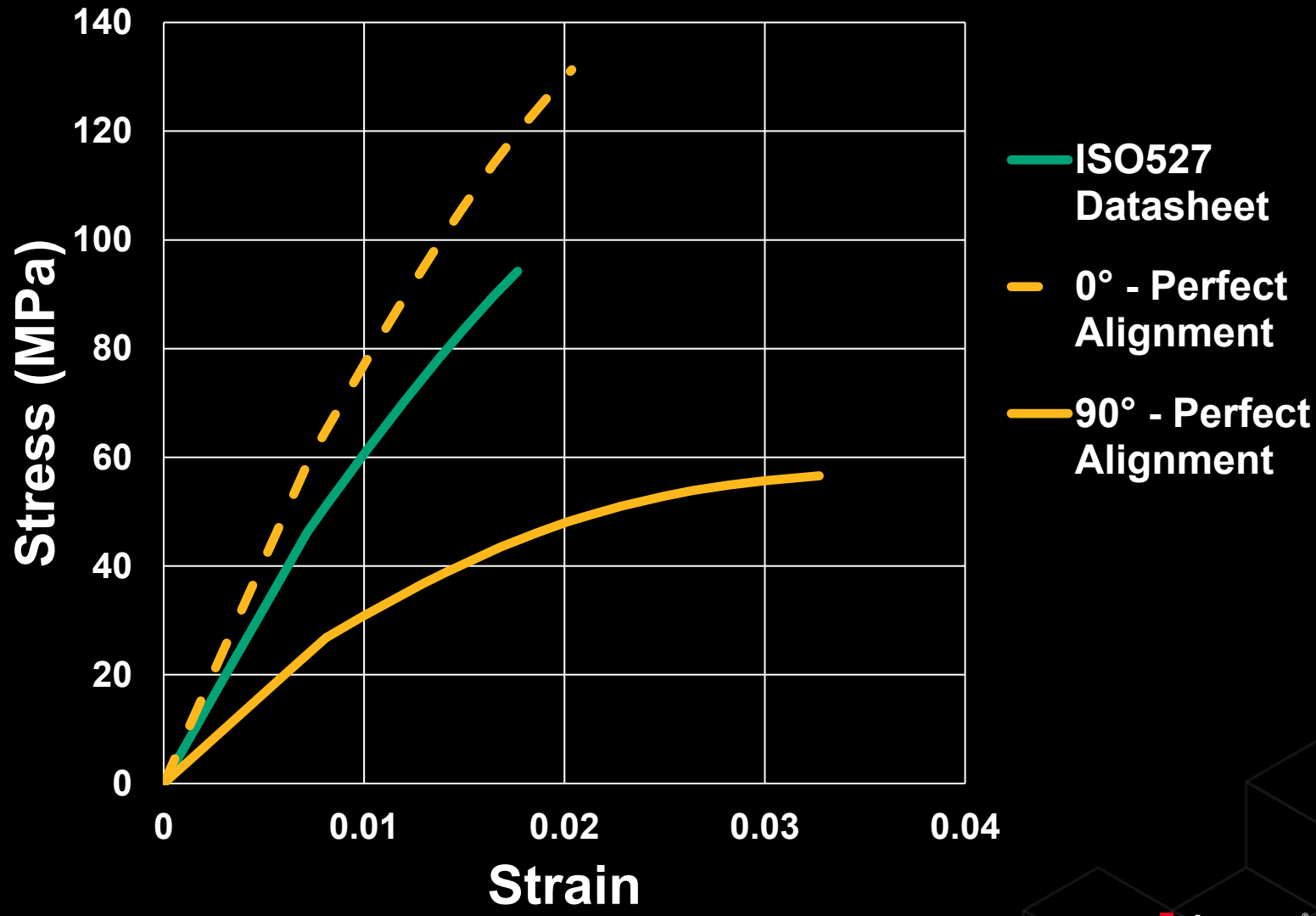
Model: Gaming controller

- Assembly : Gaming controller
- Part : Structural core
- Solver : Marc
- Fixed :
- Pressure : 0.3MPa

Case Study

Material: Fiber reinforced polymer & datasheet

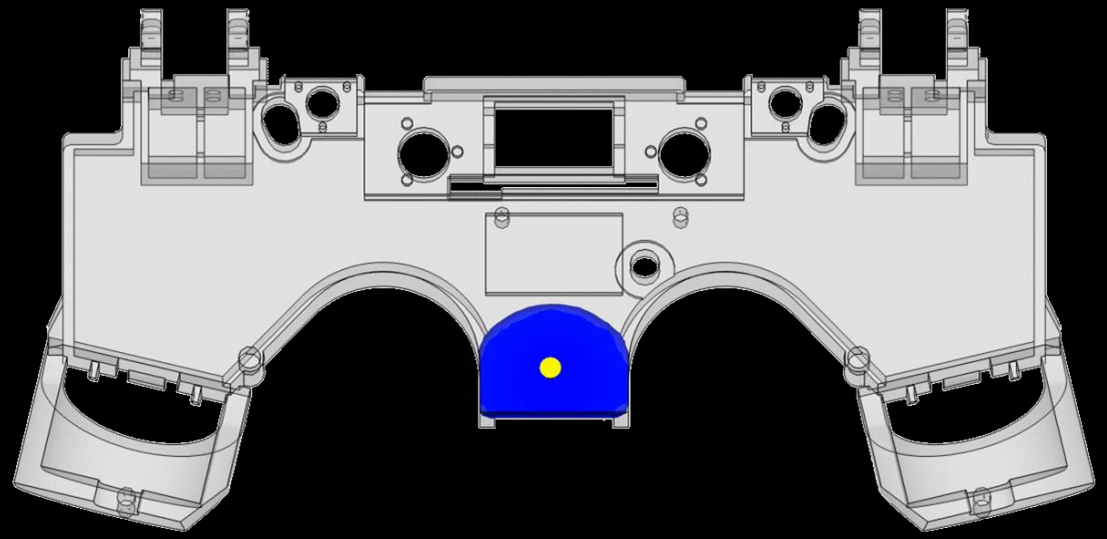
- Material
  - Reinforcement : Glass
  - Mass fraction : 20%
  - Matrix : PC/ABS
- Conditions
  - Temperature : 23°C
  - Conditioning : N/A



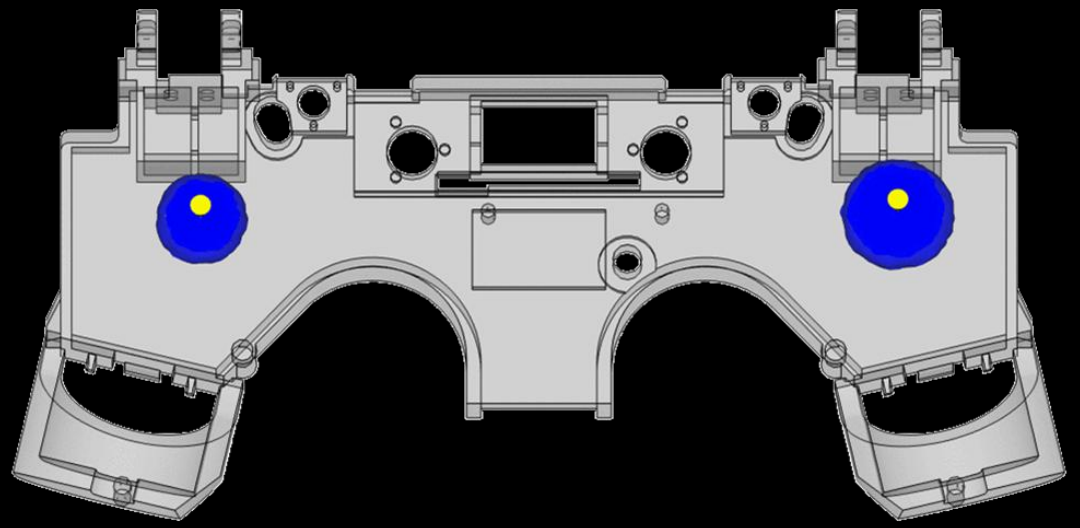
Case Study

Manufacturing data: Fiber reinforced polymer

- Single gate



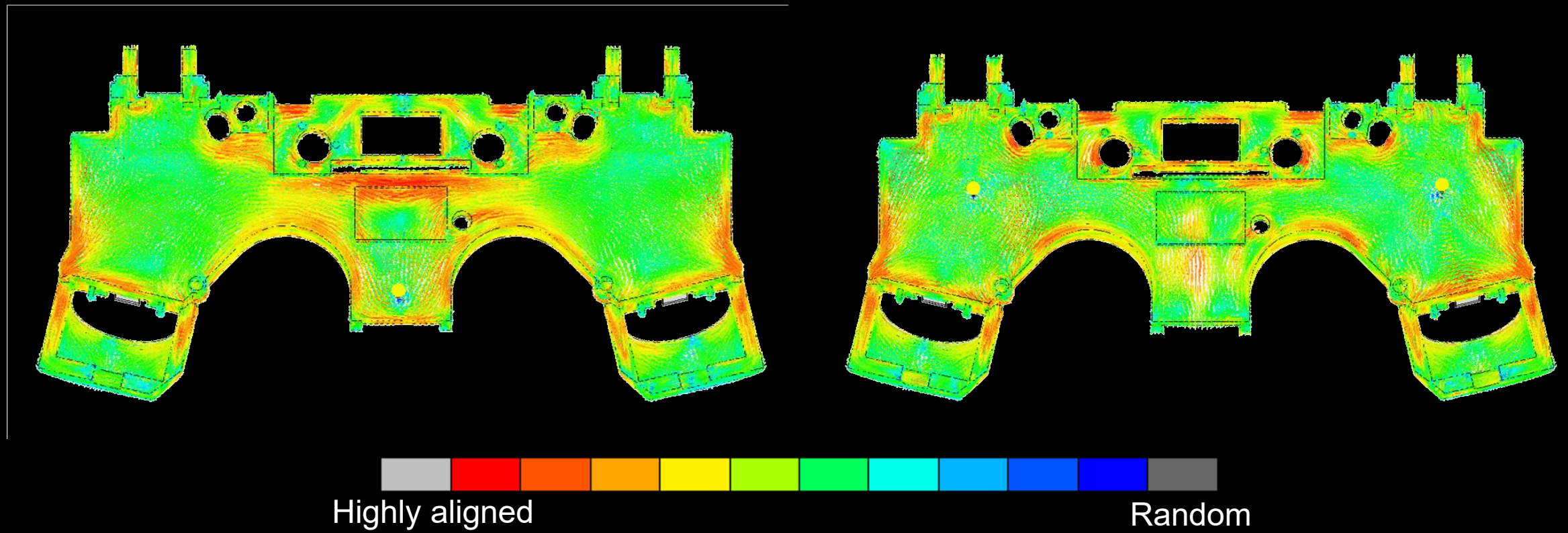
- Double gate



Case Study

Manufacturing data: Fiber orientations

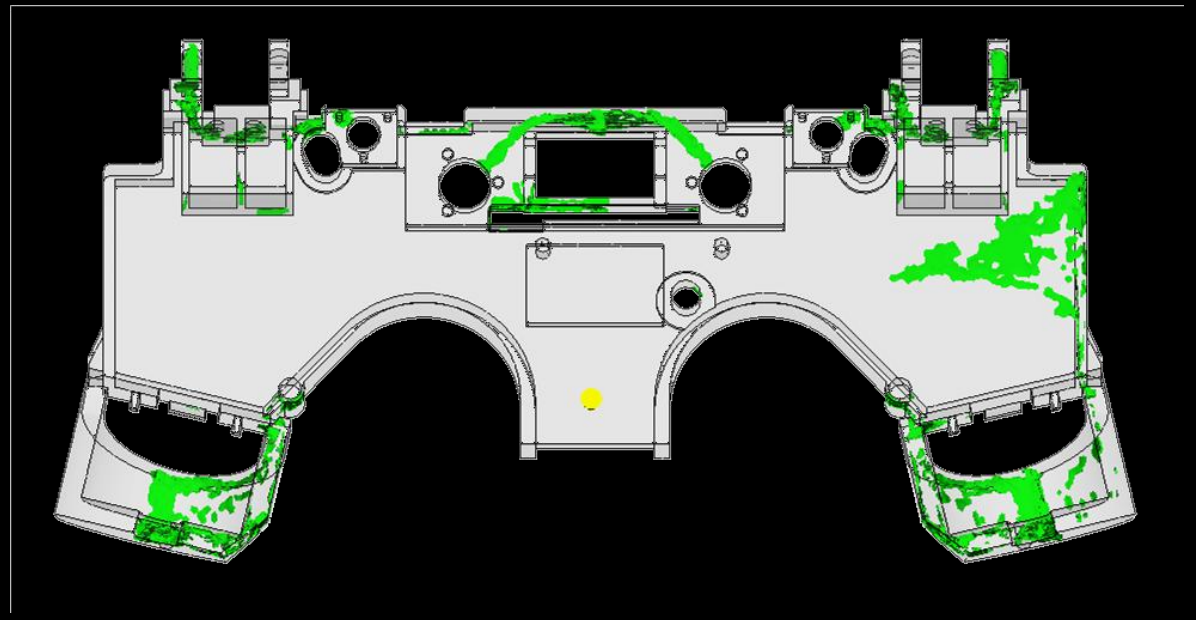
- Single gate
- Double gate



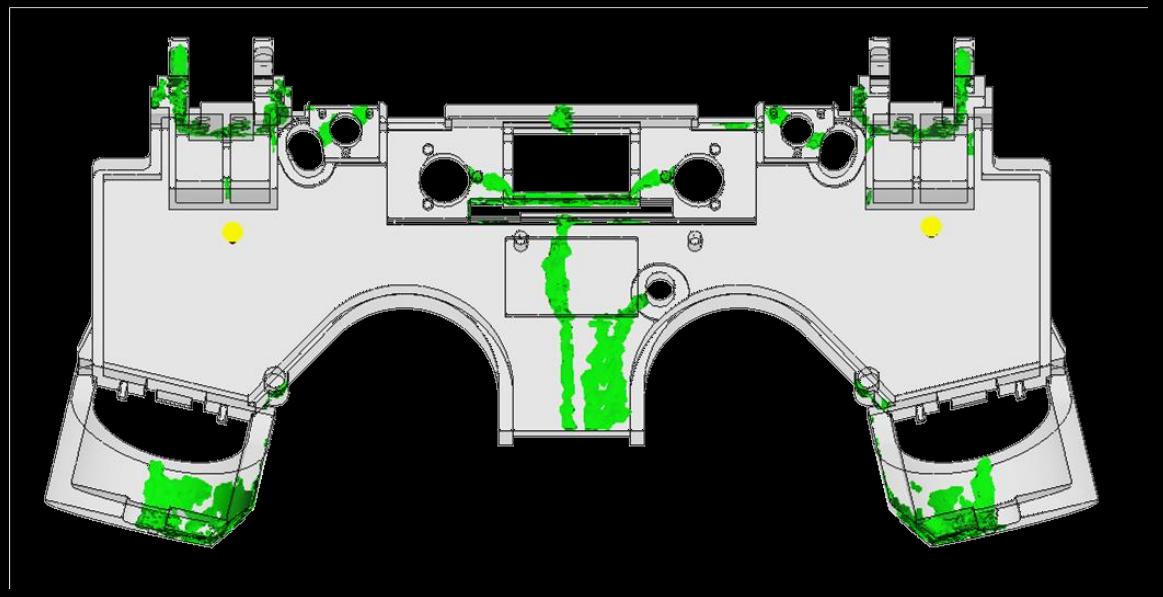
Case Study

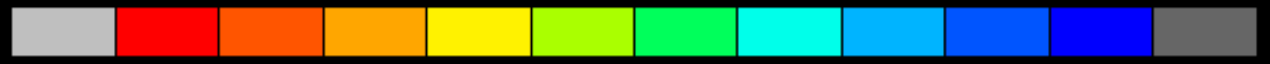
Manufacturing data: Fiber orientations

- Single gate



- Double gate





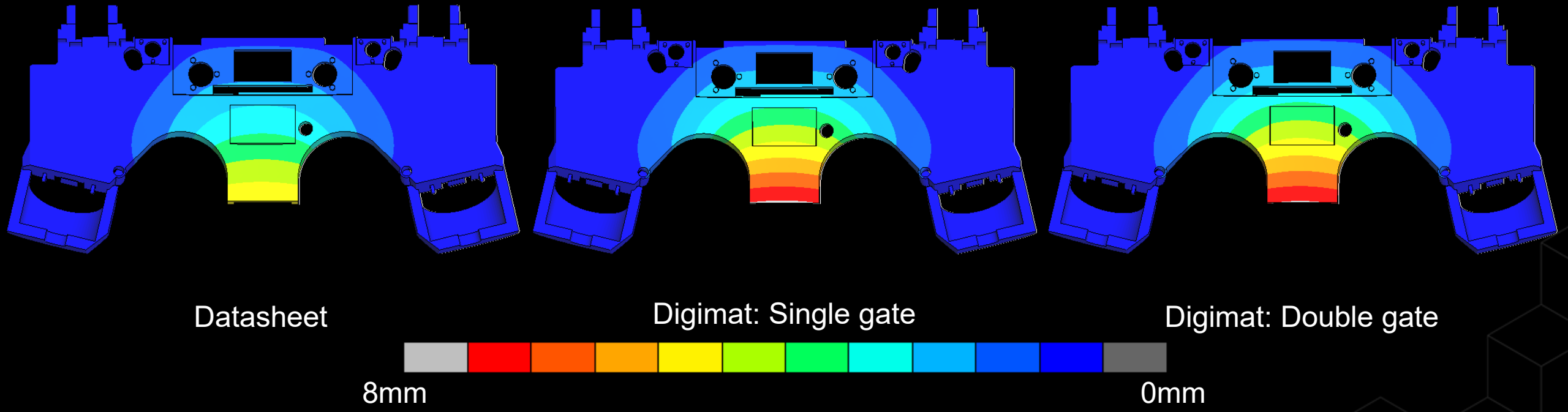
Highly aligned

Random

Results

Results
Displacement

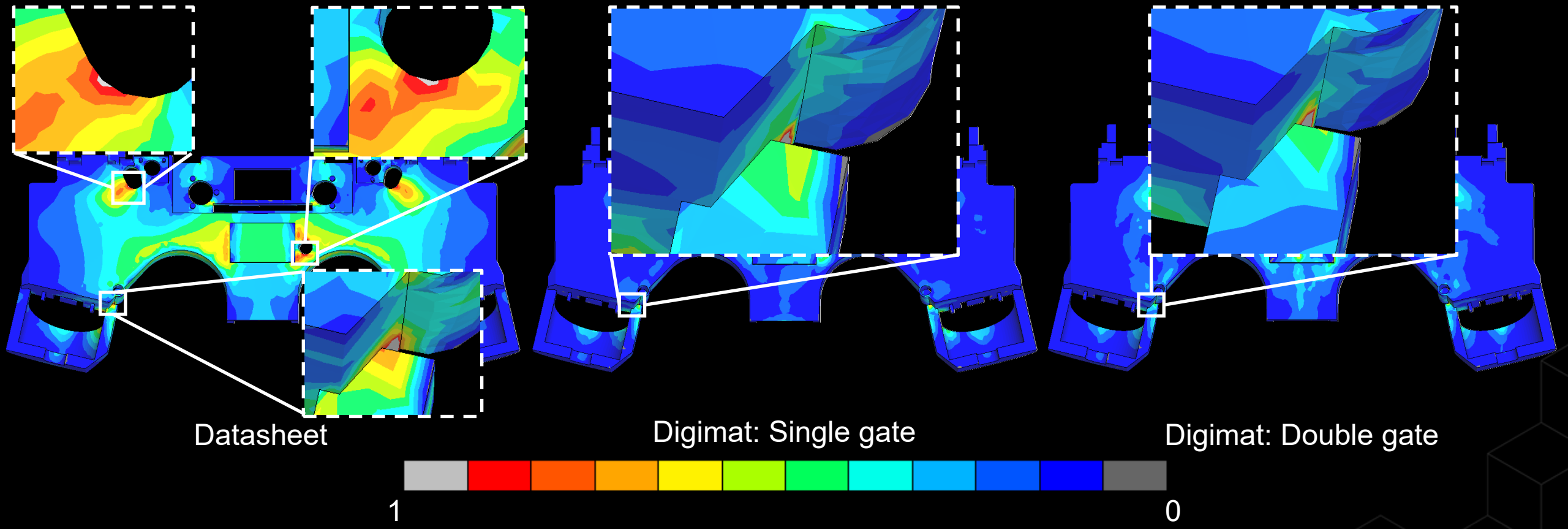
- Single gate & double gate Digimat models show similar overall displacement
- Isotropic datasheet model shows significantly lower displacement



Results

Failure indicator

- Significantly greater risk of failure in isotropic datasheet model



Results

Gate position analysis

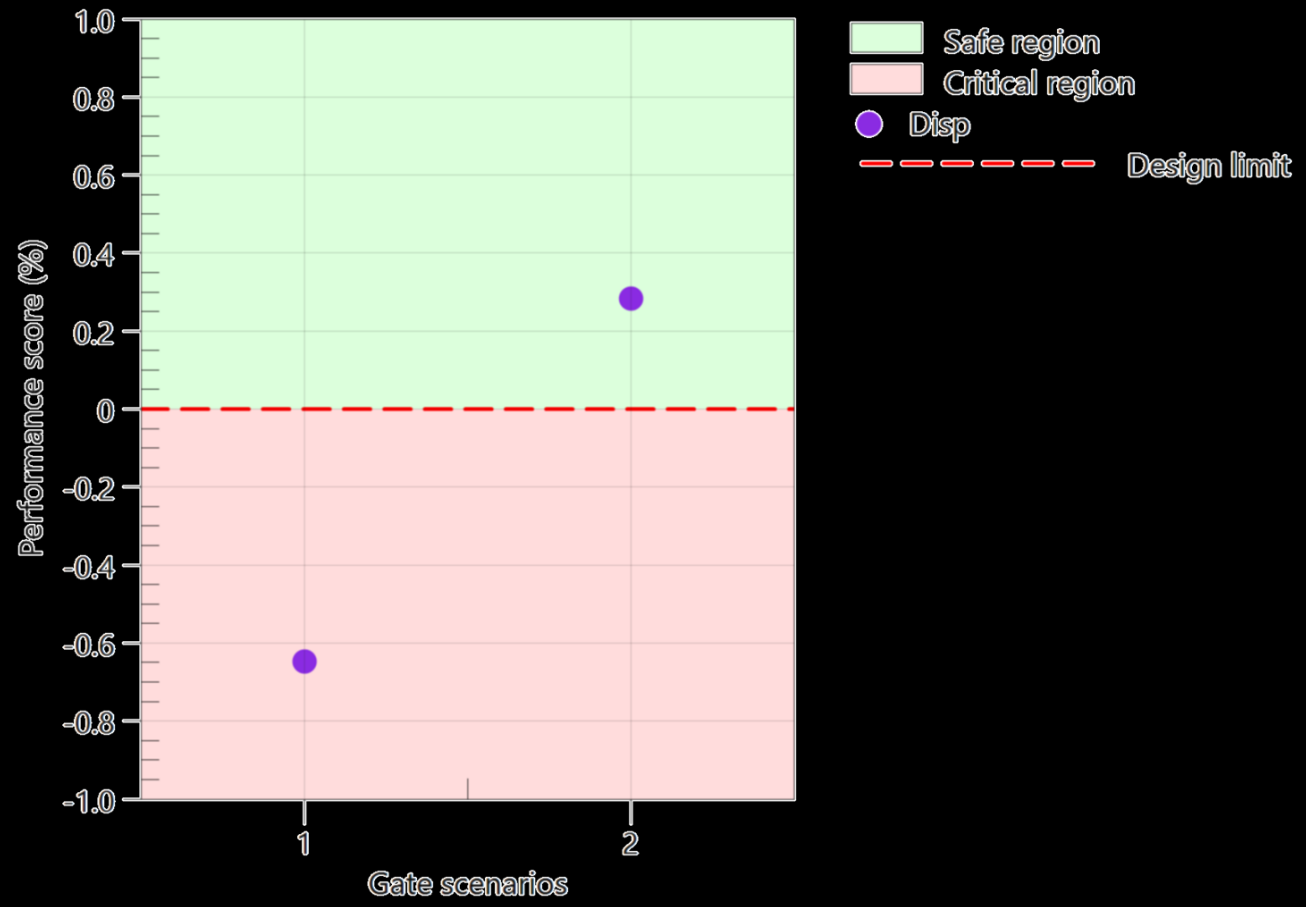
- Key performance indicators
  - Displacement
    - Component : Magnitude
    - Threshold : <8.13mm
  - Plastic strain
    - Rule : 0.05% of integration points
    - Threshold : <0.0095
  - Failure indicator
    - Rule : 0.02% of integration points
    - Threshold : <1

Rule: Magnitude
Threshold: <8.13mm

Results

Displacement

- Best scenario recommendation : Double gate (gate scenario 2)
- Weighted performance score : 0.284%

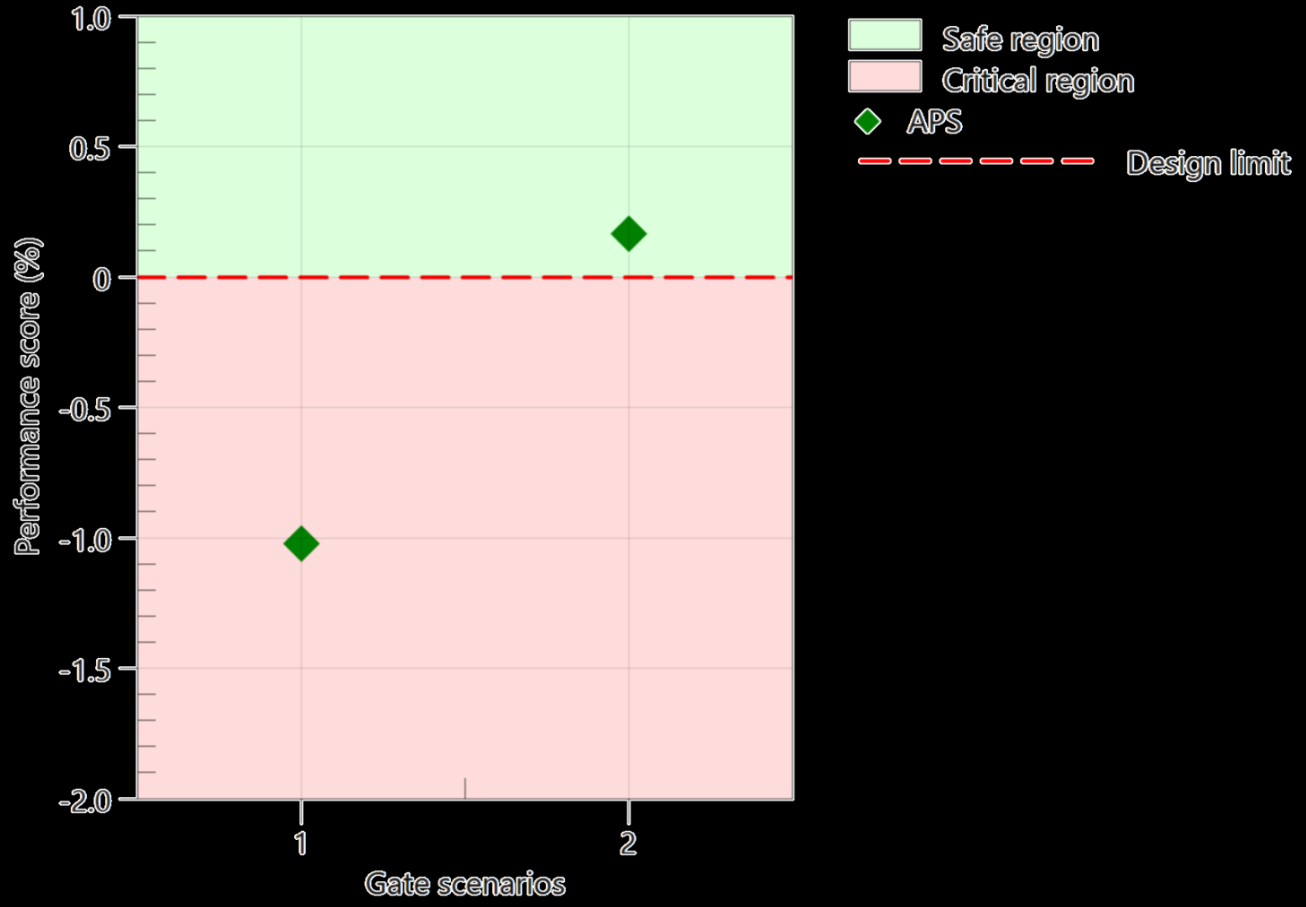


Rule: <0.05% of integration points
Threshold: <0.0095

Results

Plasticity

- Best scenario recommendation : Double gate (gate scenario 2)
- Weighted performance score : 0.166%

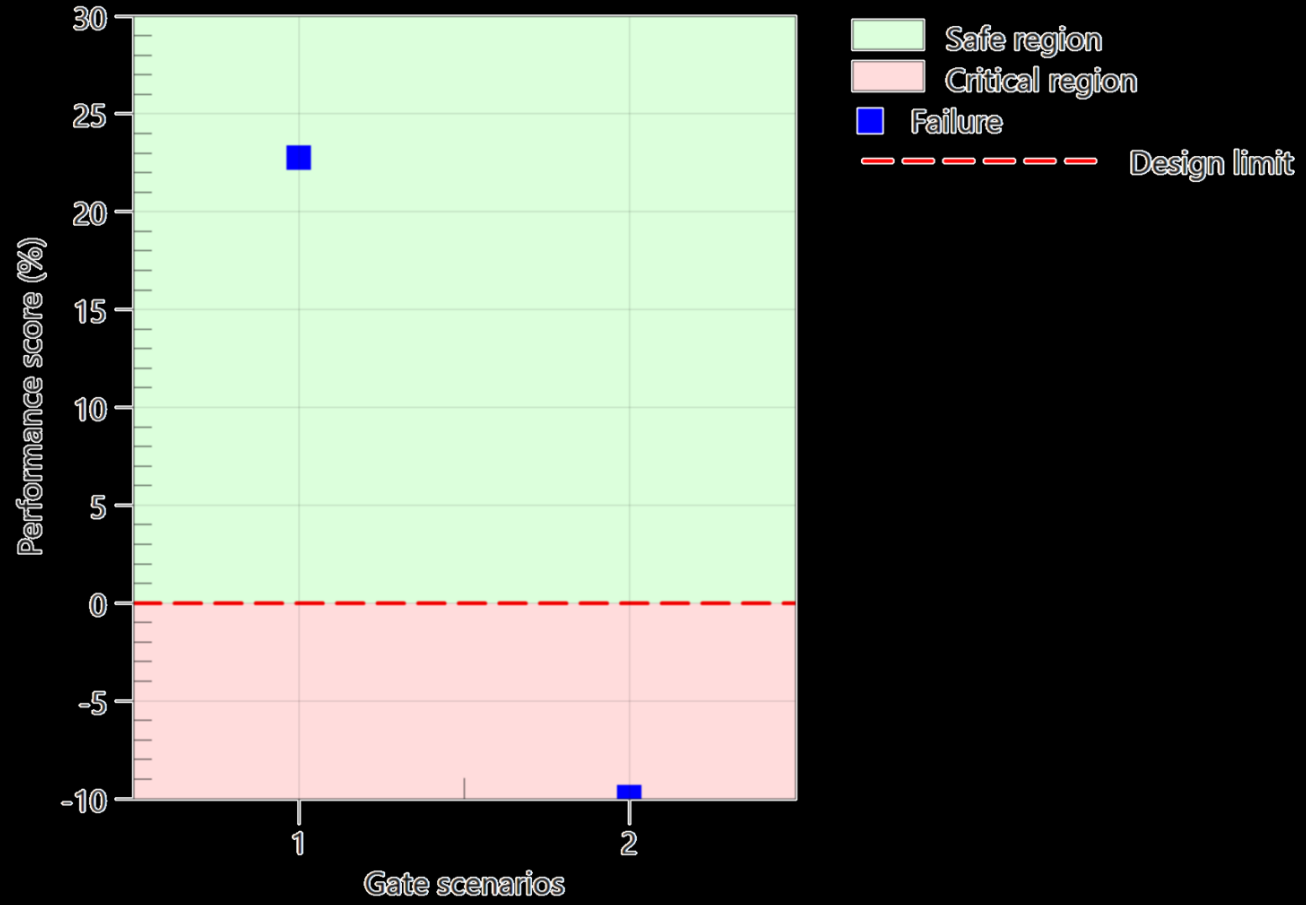


Rule: <0.02% of integration points
Threshold: <1

Results

Failure indicator

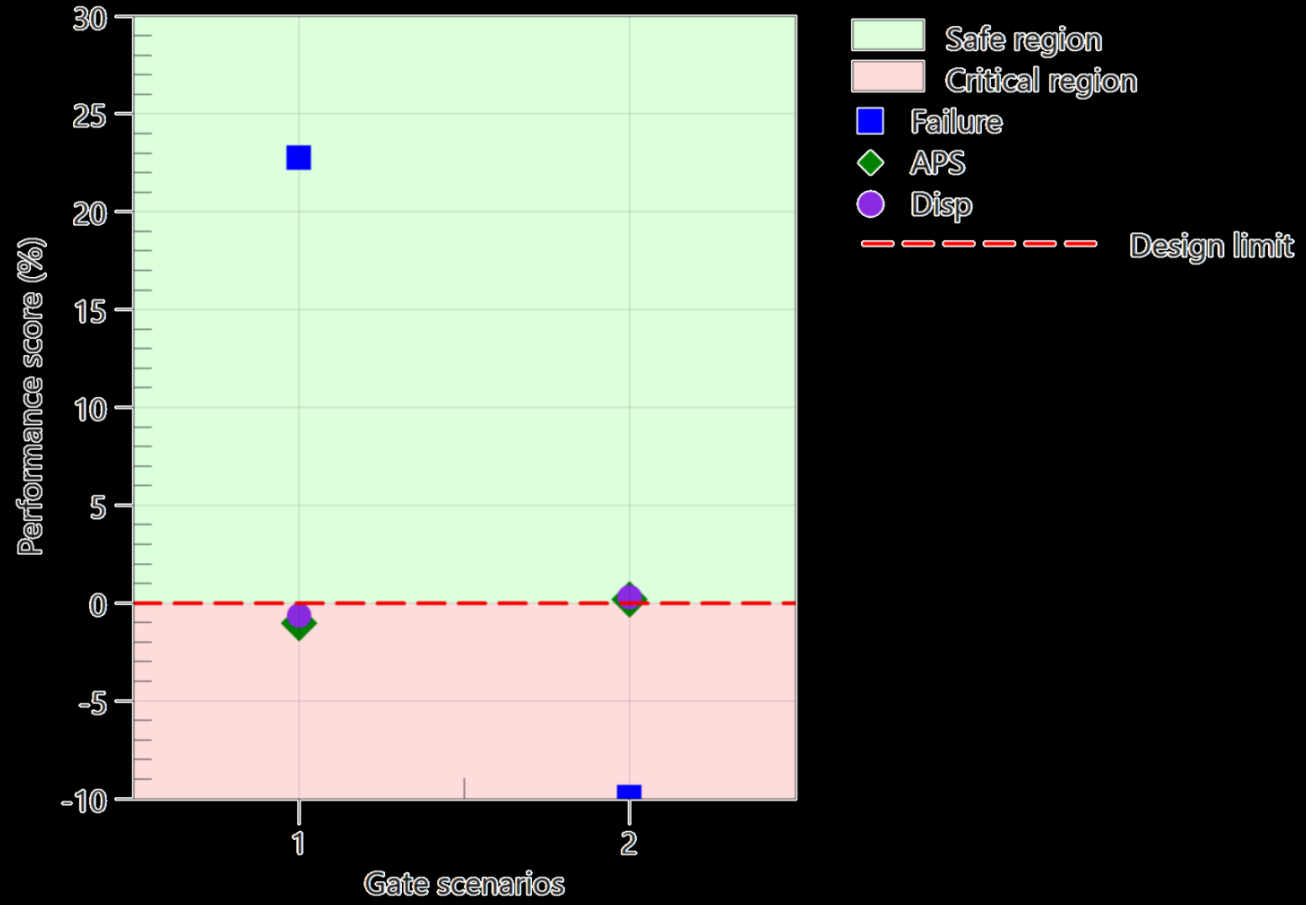
- Best scenario recommendation : Single gate (gate scenario 1)
- Weighted performance score : 22.7%



Results

All KPIs combined

- Best scenario recommendation : Single gate (gate scenario 1)
- Weighted performance score : 4.8%



Conclusions

Conclusions

- Regulations & customer wants pushing toward lightweighting → Composites & polymers
- Manufacturing process determines fiber orientations which affect stiffness & strength
- Connect manufacturing process to structural performance to prevent over or under-design
- Digimat bridges this gap along with providing intelligent anisotropic material models
- Gaming controller case study shows:
  - Displacement : Isotropic datasheet model shows significantly lower magnitude
  - Failure : Isotropic datasheet model shows extensive failure in multiple locations
  - Gate position analysis : Gives performance score based on how much indicator passes threshold values
  - Best configuration : Accounting for displacement, plasticity & failure → Single gate model shows best results

Thank you!

Questions?

dsouza@cadence.com