# Spider bracket

Project by
Altair: Luca Frattari
Renishaw: Charlie Birkett
Materialise: Jan Lens

Presenter
Materialise Design Engineer
Dongho Kim

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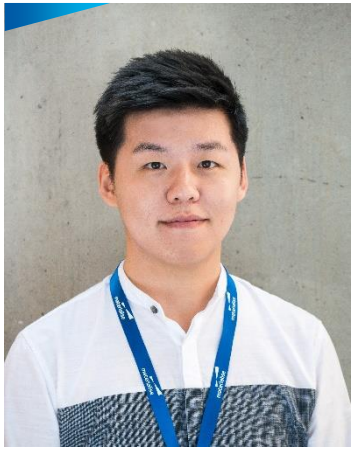
# Presenter 소개

"3D프린팅 기술을 통한 새로운 시선으로 가치를 더하다"

- 김동호 연구원은 Materialise의 설계 엔지니어로, Design for Additive Manufacturing 아카데미 및 사례 발굴을 통해 국내 3D 프린팅 활용범위의 확장을 위한 기술지원을 하고 있습니다.



Design Engineer
Dongho Kim

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- DfAM, 적층제조를 위한 디자인
  : 위상최적화가 AM빌드에도 최적화 되어있는가?
  : Metal 프린팅을 위한 기본 요소 살펴보기
- Materialise 3-matic을 활용한 AM 디자인 최적화 시연
  : 스파이더 브라켓 케이스 Workflow 소개
  : 케이스 스터디 데모 시연 in 3-matic
- Q & A


# 머티리얼라이즈 소개

# About Materialise

## We are the innovators you can count on.

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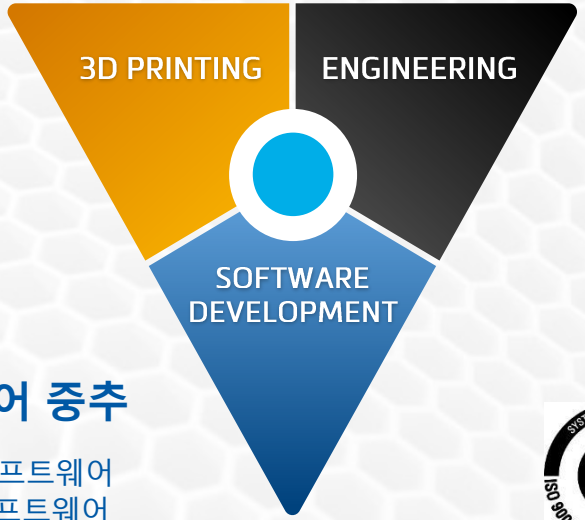
### The Future of Factory

+180 3D Printers
+30 Materials
+90 Finishes




### 의미있는 사례

+267 patents granted
+182 patents pending

### 3D 프린팅 산업의 소프트웨어 중추

| | |
|---|---|
| Magics | 사실상 Data Prep 표준 소프트웨어 |
| 3-matic | Design For AM 최적화 소프트웨어 |
| Build Processor | 장비 플랫폼 Machine Communication |
| Streamics | AM을 위한 생산관리 |

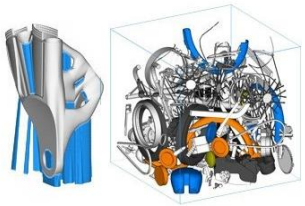
SYSTEM CERTIFICATION ISO 9001 SGS
SYSTEM CERTIFICATION ISO 13485 SGS
SYSTEM CERTIFICATION EN 9100 SGS

# Materialise S/W Enabling Industry 4.0

From CAD to Printed Part

**CAD File**
**FEA File**

**Design Optimization**
Materialise 3-matic



**File Preparation**
Materialise Magics

**Machine Communication**
Materialise Build Processor
Materialise Control Platform

**Result:**
**A Quality Part**
Materialise Inspector

**Planning & Automation**
Materialise Streamics

# Materialise 3-matic

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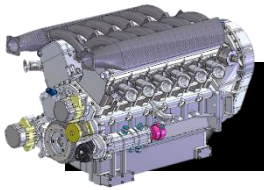
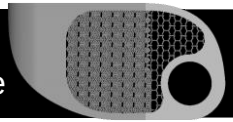
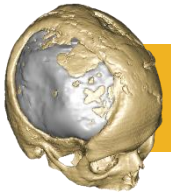
## Design workflows for AM



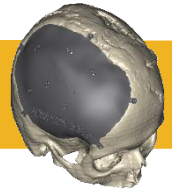
**Parametric Design (CAD)** → Textures & Lattice Structure



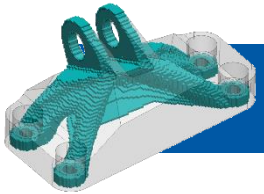
→ Slicing & hatching with BP before printing



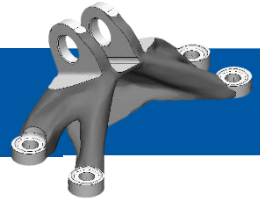
**Scanned Data** → Fixing & STL-design



→ Medical production



**Topology Optimization** → Cleanup & redesign



→ Small series production

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# DfAM, 적층제조를 위한 디자인

1. 위상최적화가 AM빌드에도 최적화 되어있는가?
2. Metal 프린팅을 위한 기본 요소 살펴보기

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## DfAM, 적층제조를 위한 디자인
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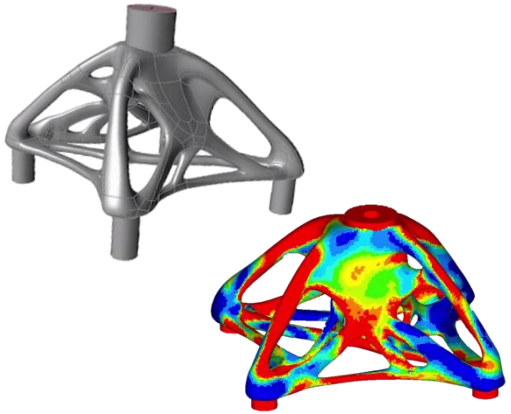

- ✓ 파트 해석 및 검증
- ✓ 재료 및 기계적 특성 이해
- ✓ 공정에 따른 제약요소 이해

**AM에도 적용되는 중요한 요소!**

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## DfAM, 적층제조를 위한 디자인
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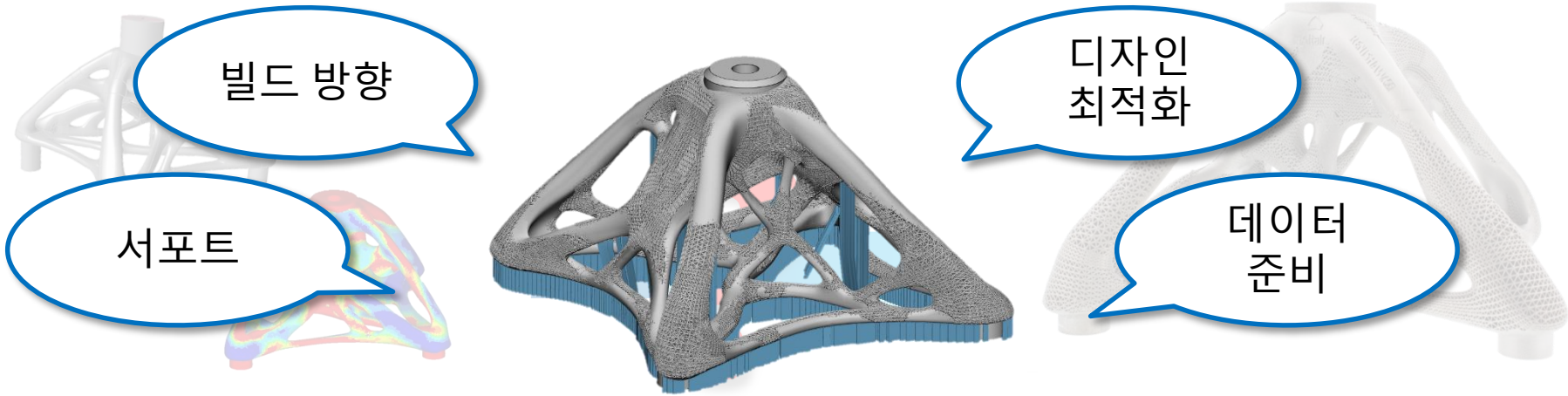


DfAM, Design For Additive Manufacturing

: Get the best out of AM and avoid common mistakes!

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# Metal 프린팅을 위한 기본 요소 살펴보기

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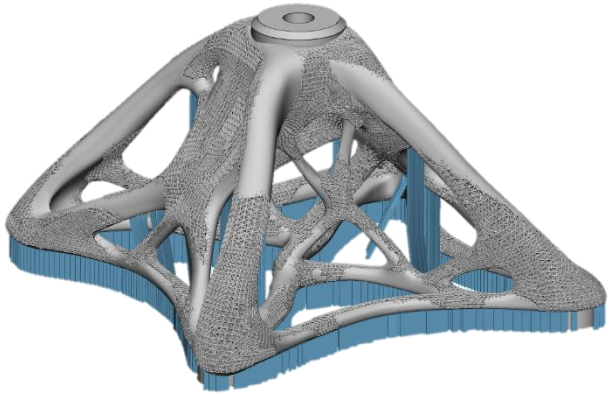
# DfAM, 적층제조를 위한 디자인
# Metal 프린팅을 위한 기본 요소 살펴보기

DfAM with Metal Knowledge

Data Prep. & Manufacturing

- Residual Stress
- Build Orientation
- Support Strategy



Design Optimization

- Clean-up Mesh
- Optimize Lattice Structure
- Following Design Rules

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# DfAM, 적층제조를 위한 디자인
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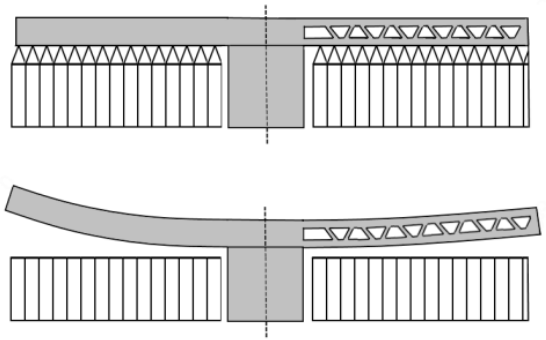
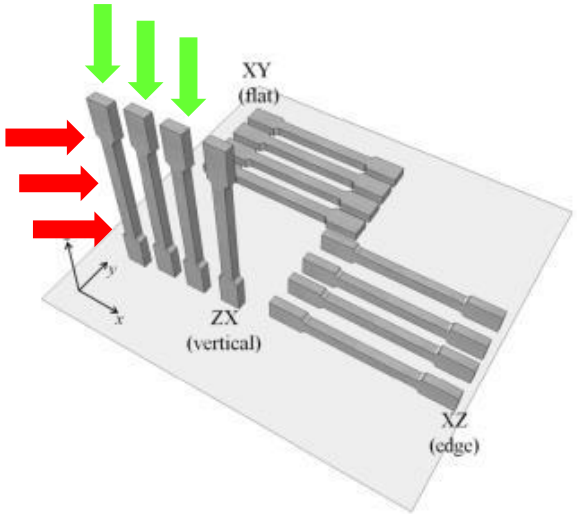


Deformation
(due to thermal stresses)




Part orientation and strength

DfAM, 적층제조를 위한 디자인

# Metal 프린팅을 위한 기본 요소 살펴보기

DfAM with Metal Knowledge

Data Prep. & Manufacturing

- Residual Stress
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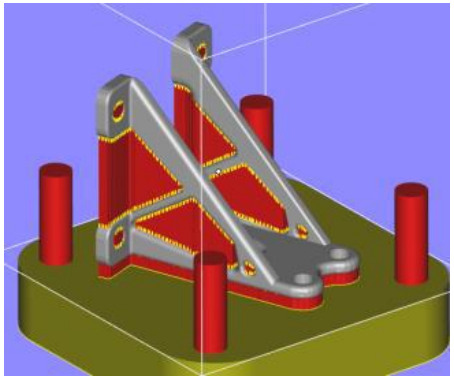
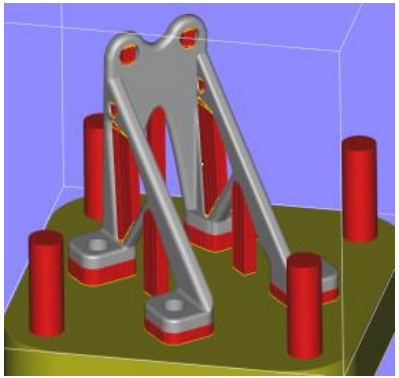


**빌드시간 ↓ 서포트 ↑**

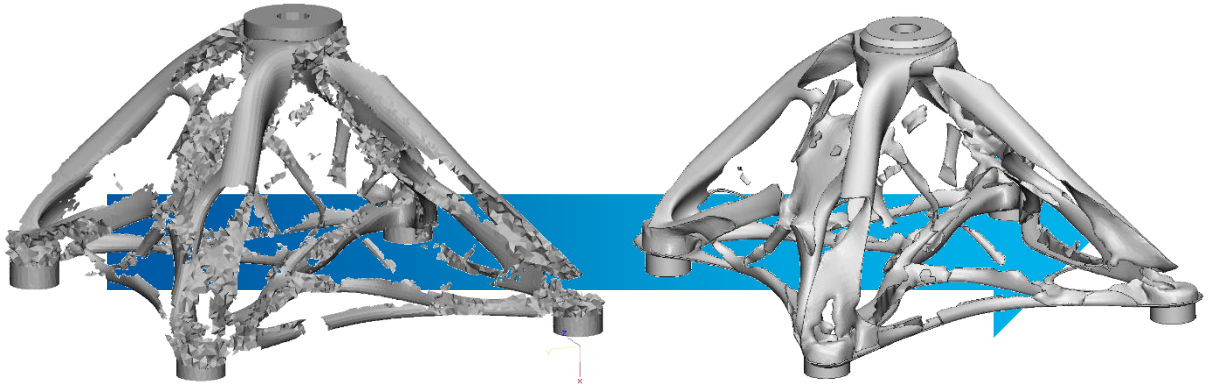


**빌드시간 ↑ 서포트 ↓**

**+ α**
**셀프 서포트 구조**
**후처리 가공 등..**

DfAM, 적층제조를 위한 디자인

# Metal 프린팅을 위한 기본 요소 살펴보기



Solid areas (rough mesh)

Solid region cleaned up in 3-matic

## DfAM with Metal Knowledge

Design Optimization

- **Clean-up Mesh**
- Optimize Lattice Structure
- Following Design Rules

DfAM, 적층제조를 위한 디자인

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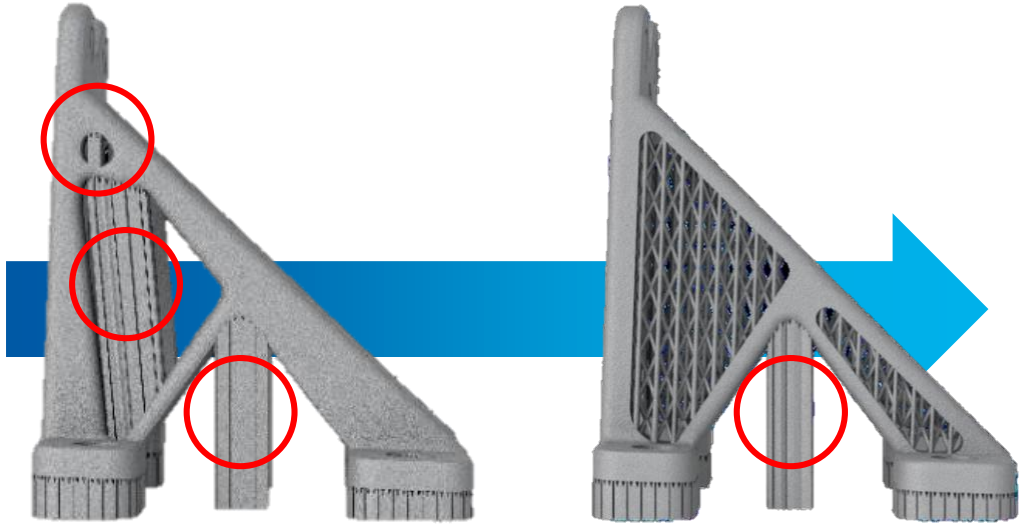

Support replacement via lattice structures

DfAM with Metal Knowledge

Design Optimization

- Clean-up Mesh
- **Optimize Lattice Structure**
- Following Design Rules

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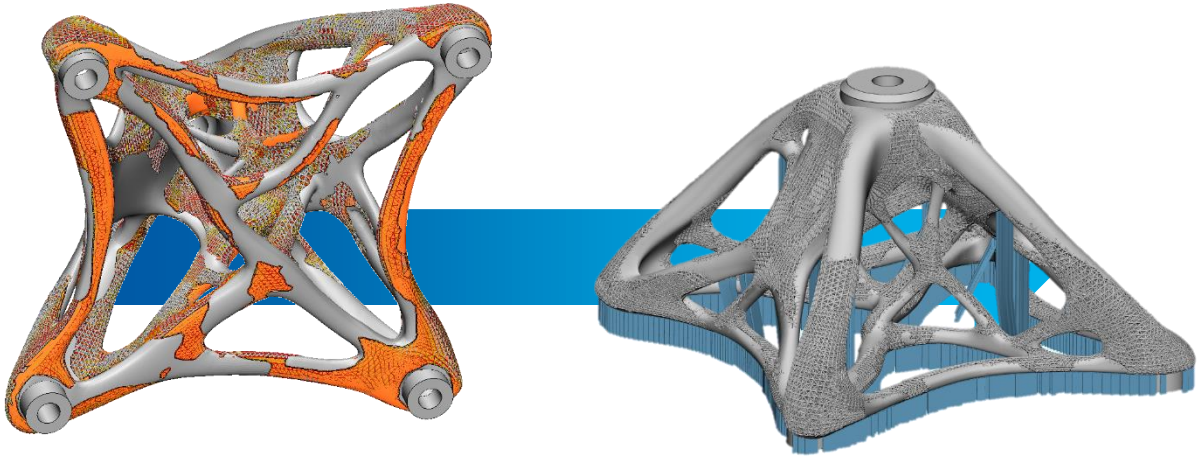
# DfAM, 적층제조를 위한 디자인
# MetaI 프린팅을 위한 기본 요소 살펴보기



Connect lattice nodes
to the cleaned surface

Not to connect support
to the lattice beam directly

## DfAM with Metal Knowledge

Design Optimization

- Clean-up Mesh
- **Optimize Lattice Structure**
- Following Design Rules

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# DfAM, 적층제조를 위한 디자인
# Metal 프린팅을 위한 기본 요소 살펴보기

## DfAM with Metal Knowledge

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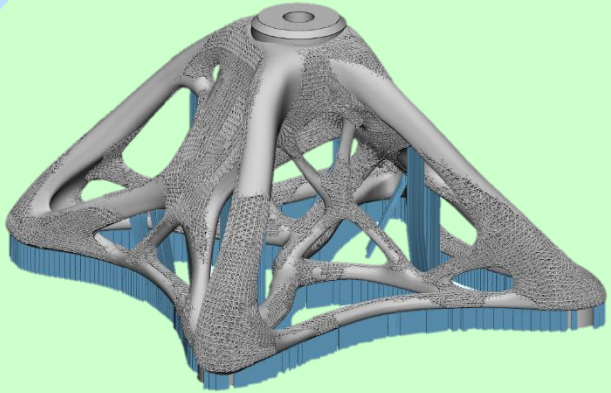

Design Optimization

- Clean-up Mesh
- Optimize Lattice Structure
- Following Design Rules

**: Get the best out of AM and avoid common mistakes!**

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# Materialise 3-matic을 활용한 AM 디자인 최적화 시연

1. 스파이더 브라켓 케이스 Workflow 소개
2. 케이스 스터디 데모 시연 in 3-matic

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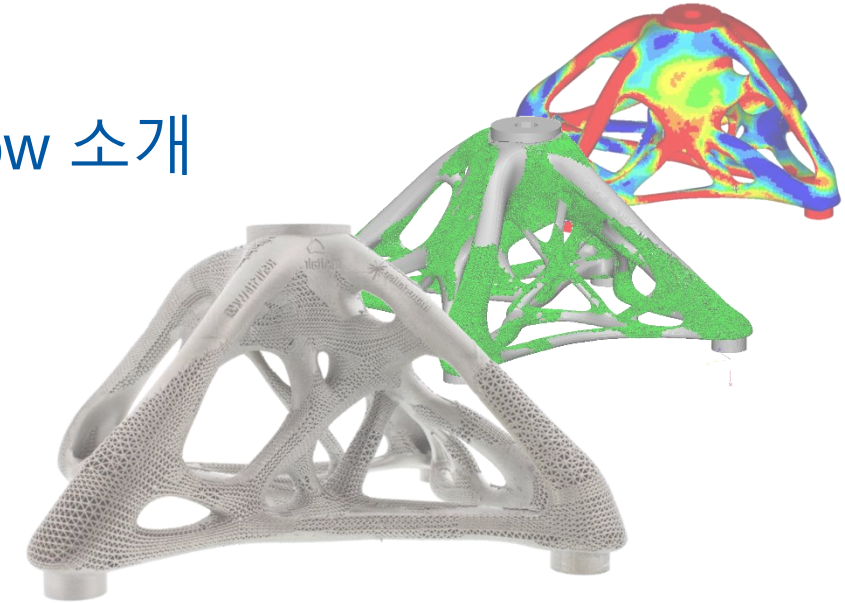
# 스파이더 브라켓 케이스 Workflow 소개



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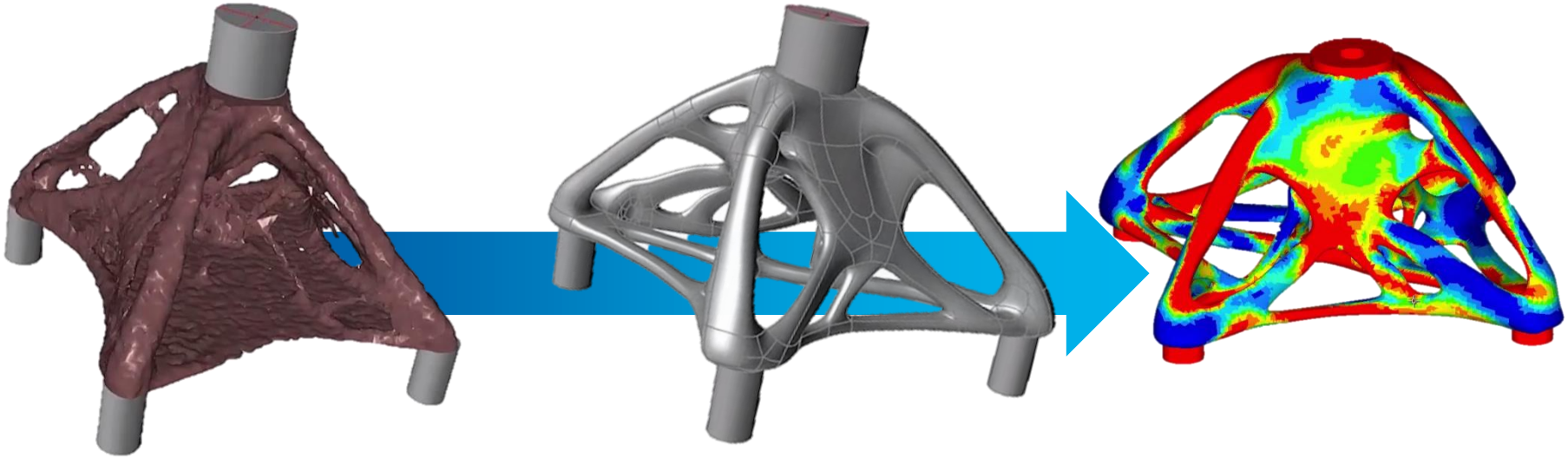
# DfAM, 적층제조를 위한 디자인
# 스파이더 브라켓 케이스 Workflow

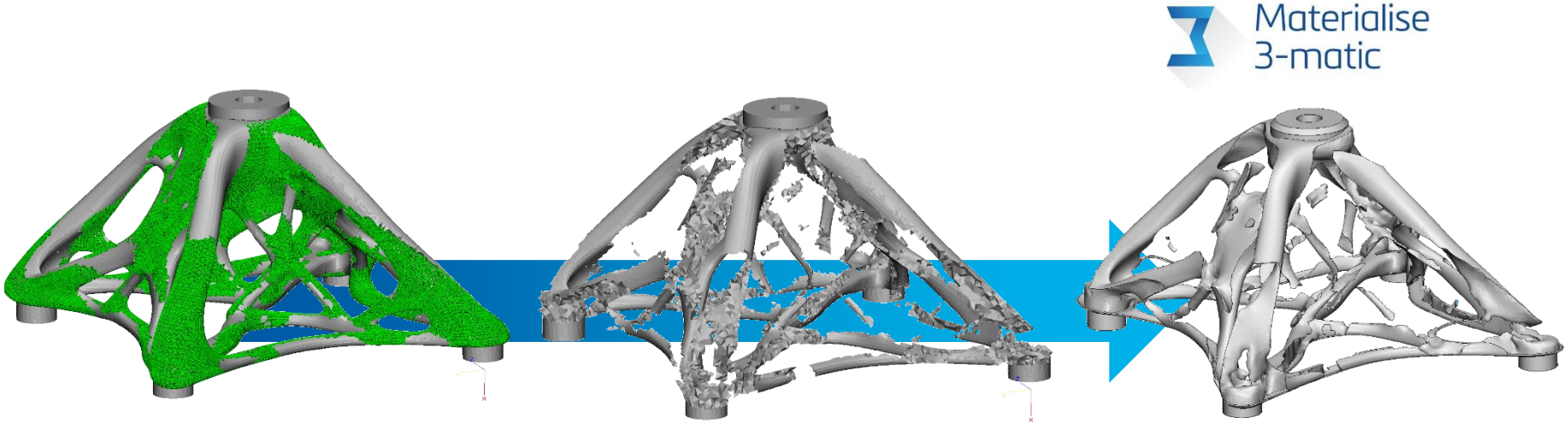


Topology optimization result

Cleaned up optimized shape

FEA on cleaned up shape

# Spider bracket: Lattice design




Lattice in low density regions (tetrahedron shapes)

Solid areas (rough mesh)

Solid region cleaned up in 3-matic

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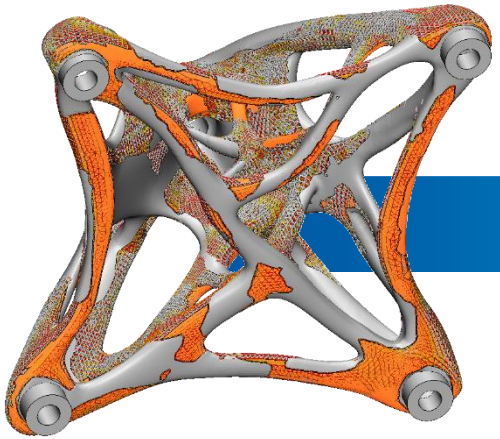
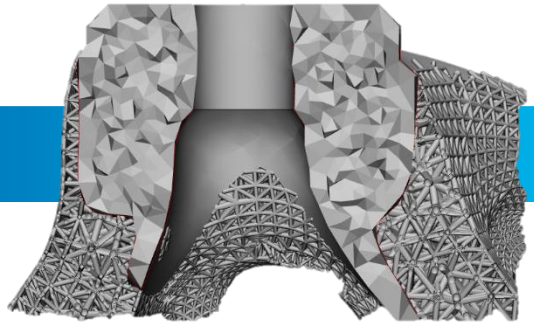
# DfAM, 적층제조를 위한 디자인
# 스파이더 브라켓 케이스 Workflow

Materialise 3-matic



Additional solid surfaces on
non-supported lattice regions

Materialise 3-matic

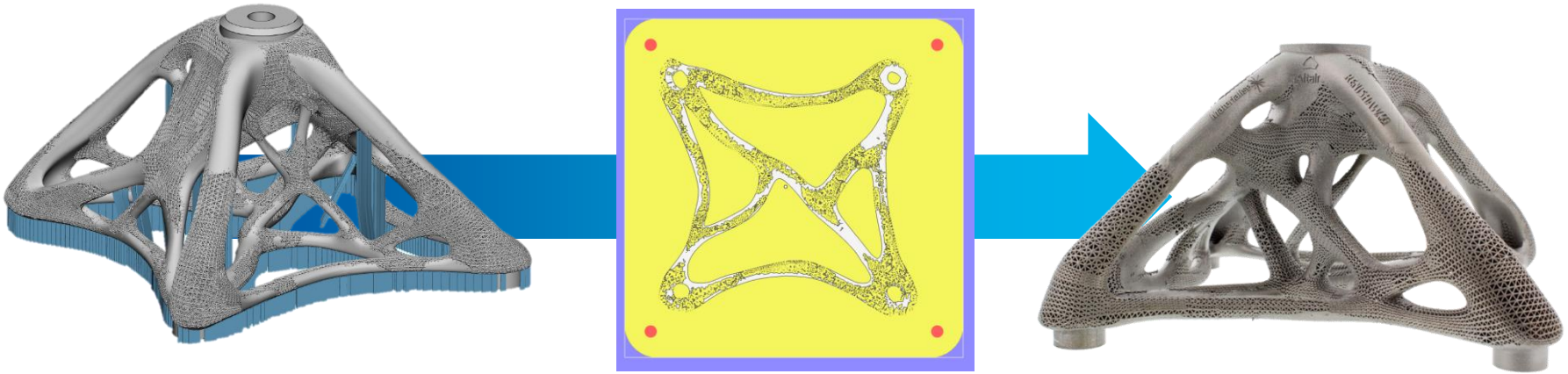


Unifrom Remesh
for FEA program

ABAQUS
ANSYS
Comsol
FLUENT
Nastran
Patran
FEM

Export to FEM and
other various FEA format

# DfAM, 적층제조를 위한 디자인
# 스파이더 브라켓 케이스 Workflow




Cleaned up solid geometry with directly sliceable lattice structure

Lattice sliced without needing to convert to STL

Reliable design & Increased printability

# DfAM, 적층제조를 위한 디자인
# 스파이더 브라캣 케이스 Workflow


- 220 000 lattice beams
- File size less than 10 MB
- Printable with minimal support needed
- No need to redesign from scratch, TO mesh can be used directly.

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# 케이스 스터디 데모 시연 in 3-matic