HORIZON 2020

caxman

computer aided technologies for additive manufacturing

COMPUTER AIDED TECHNOLOGIES FOR ADDITIVE MANUFACTURING

OMiLAB4FoF: An environment to design and develop modelling methods for the Factory of the Future

Jean Claude Morel, Missler Software
Jc.morel@topsolid.com

http://www.CAxman.eu
09/2015-08/2018.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680448

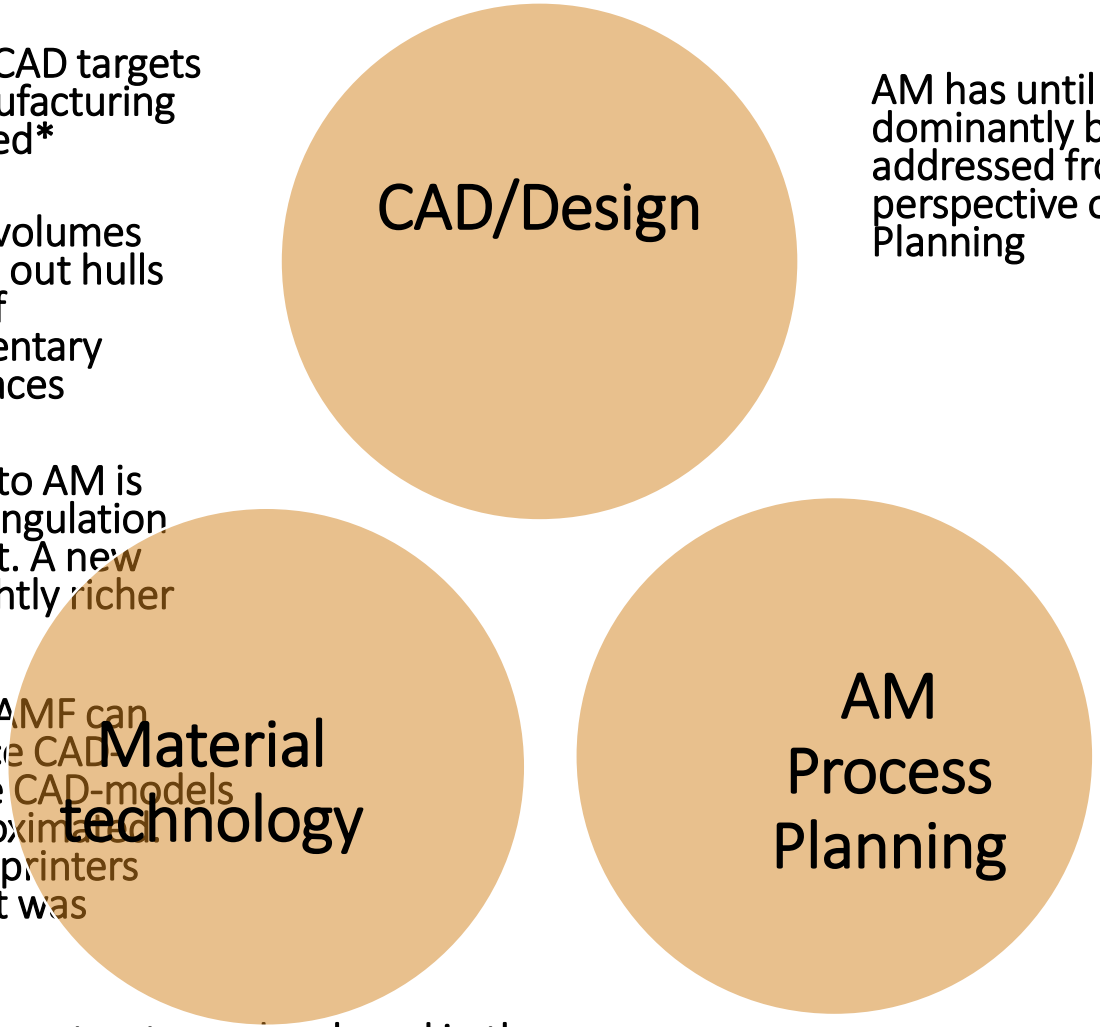
Additive Manufacturing (AM) involves many competences

State-of-the art CAD targets subtractive manufacturing and is B-rep based*

B-rep describes volumes by their inner an out hulls as patchworks of (trimmed) elementary and NURBS surfaces

Geometry input to AM is most often a triangulation in the STL-format. A new option is the slightly richer AMF format

Neither STL nor AMF can exactly reproduce CAD descriptions, the CAD-models have to be approximated. This is similar to printers before Postscript was introduced.



AM has until now dominantly been addressed from the perspective of Process Planning

caxman

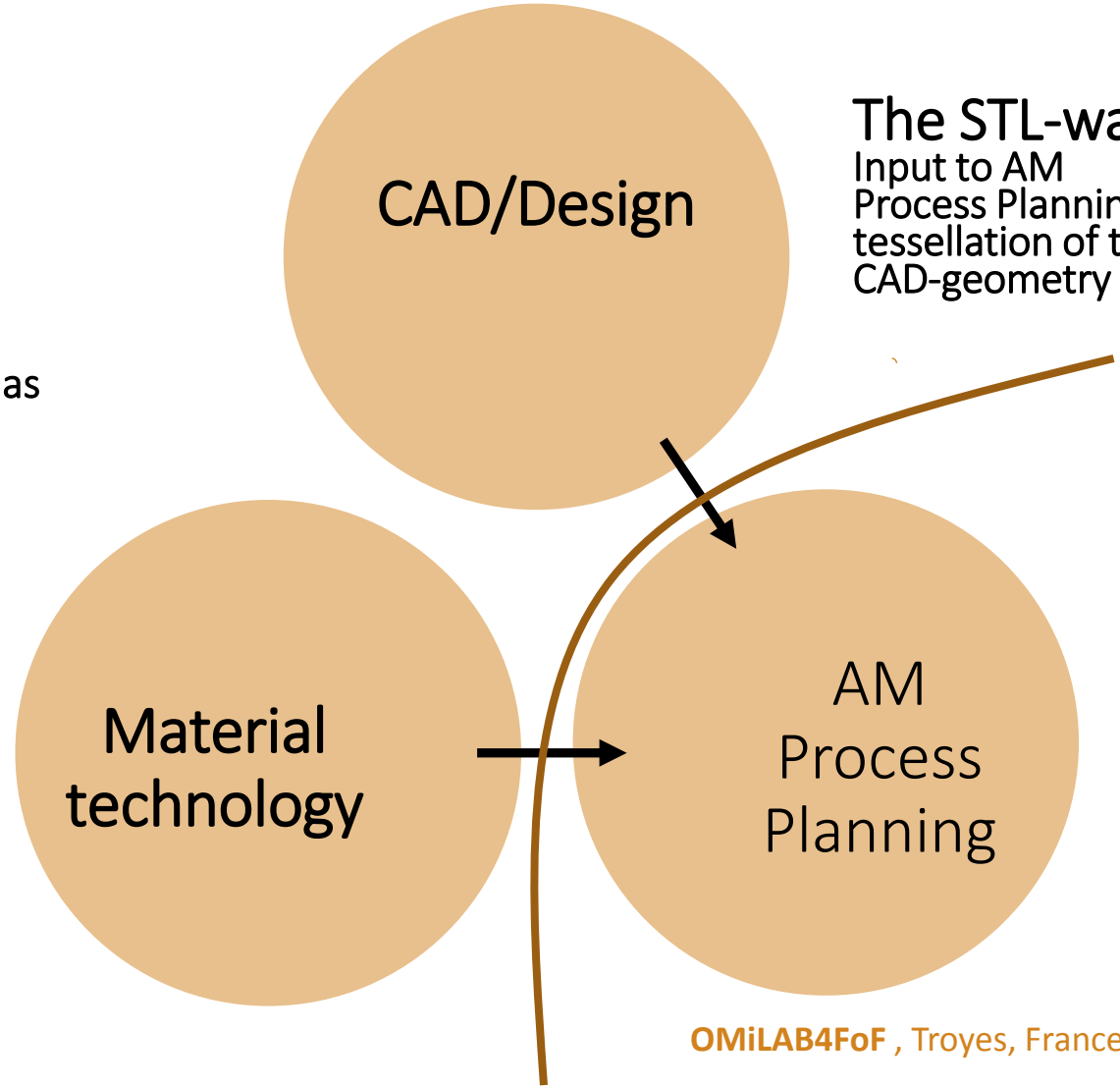
* B-rep – Boundary structures developed in the 1980s, and standarized in STEP (ISO 10303) in the 1990s

Very little interoperability with AM – One way information flow

To update a CAD-model from AM Process Planning is very complex

Support structures are today designed as part of process planning

Design of support structures, complex inner structures and anisotropic material very limited in current CAD



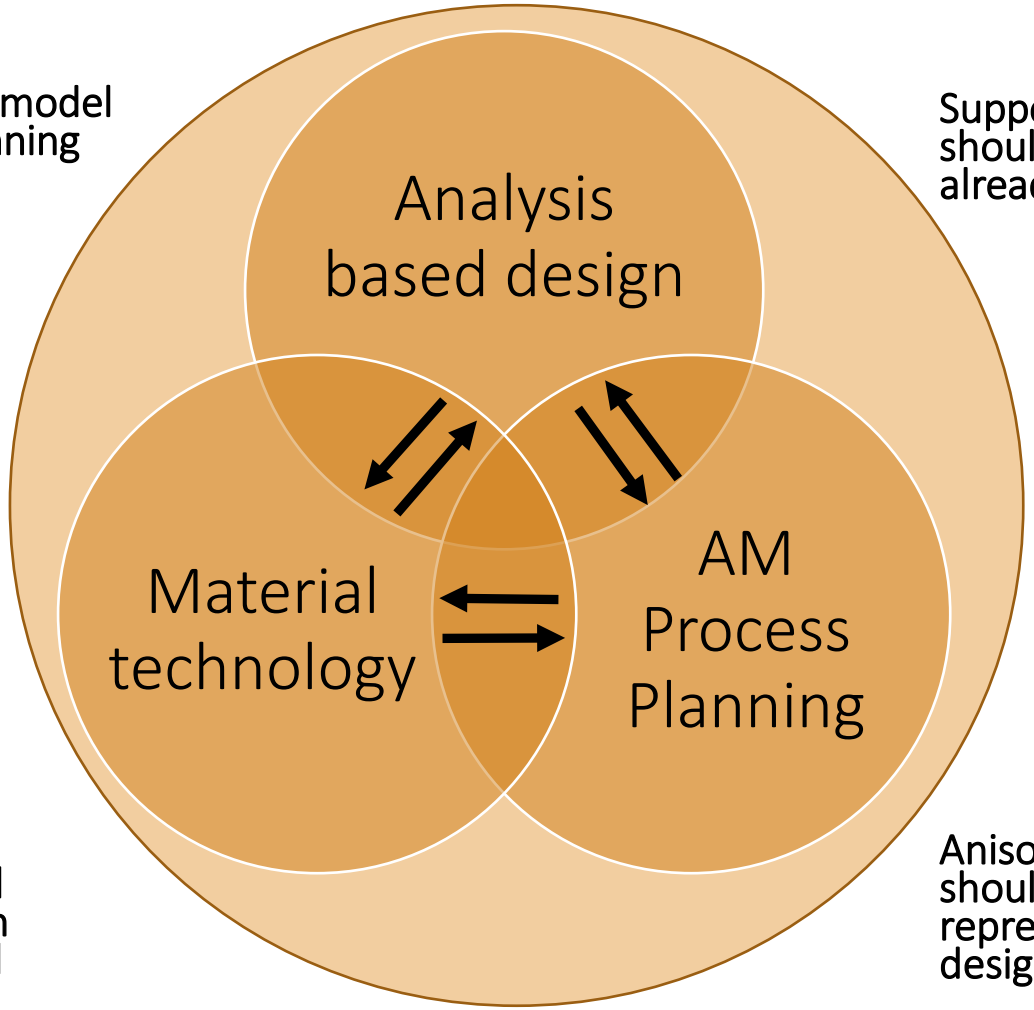
The STL-wall
Input to AM Process Planning is a tessellation of the CAD-geometry

caxman

Interoperablity essential in future CAx-technologies for AM

Update of design model after Process Planning should be simple

Support structures should be addressed already during design



Complex inner structures should be represented in the design model

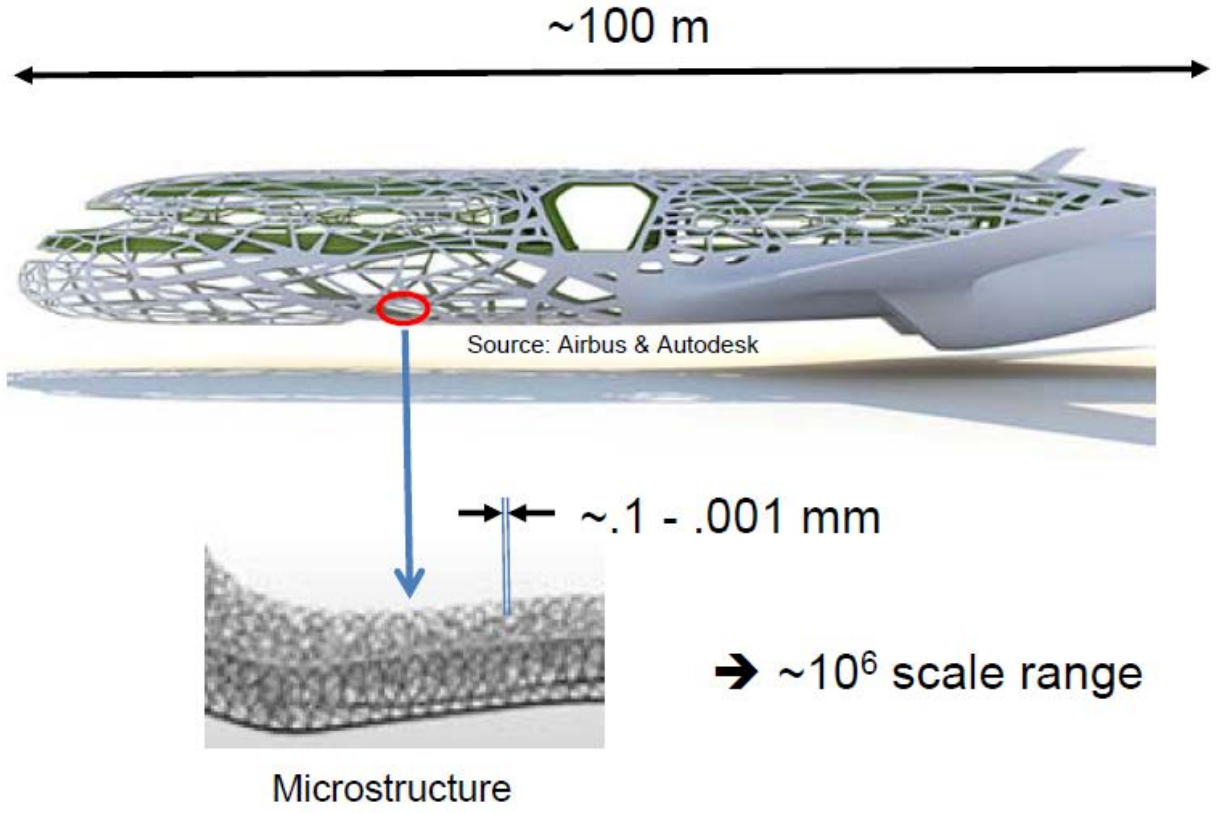
Anisotropic material should be represented in the design model

caxman

Source for slide: Jan Vandenbrande, DARPA, presentation at SIAM GD, Salt Lake City, October 2015

Immediate challenges to CAx* for AM

- Scale
- Descriptions
- Methods
- Analysis
- Abstractions
- Semantics



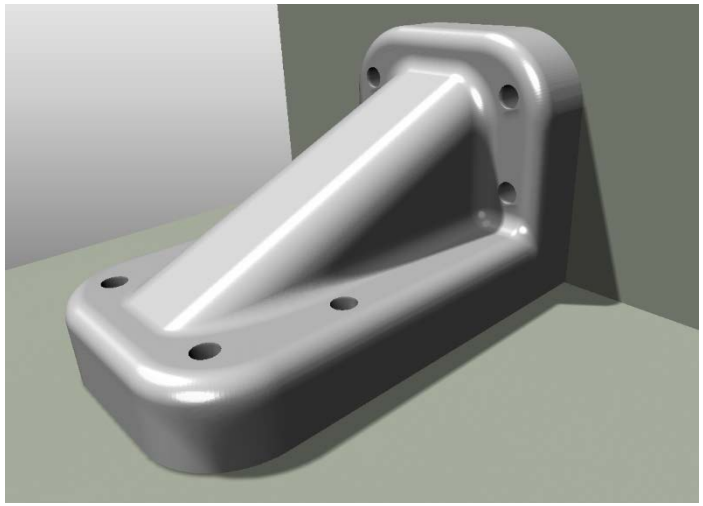
caxman

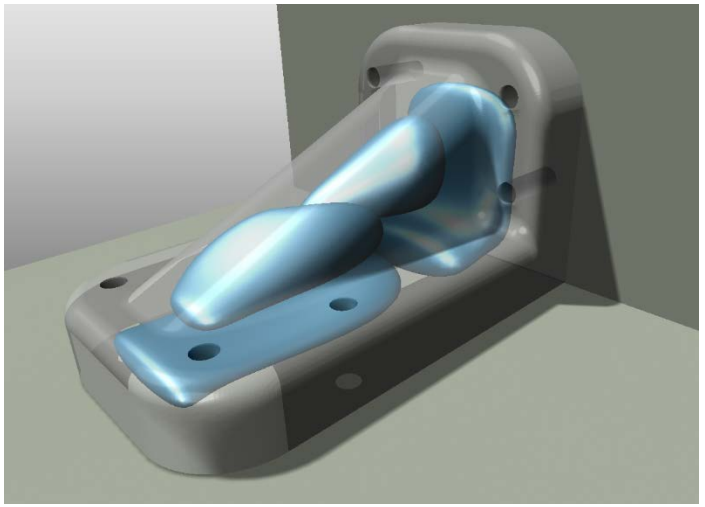
Current representations cannot handle complexity of micro-structure in conjunction with a larger structure

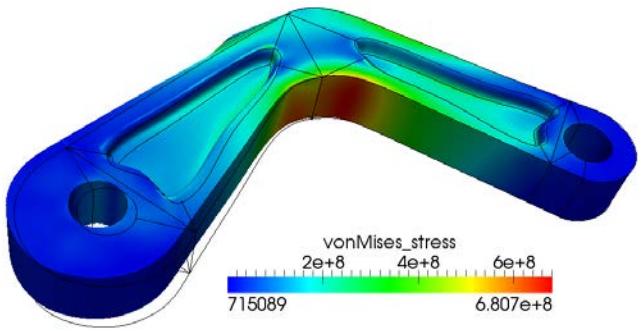
* CAx – Computer Aided Technologies

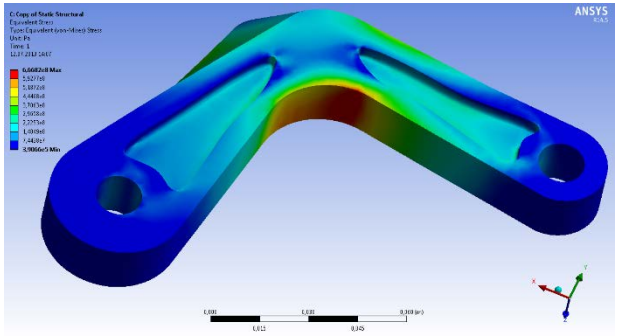
Immediate challenges to CAx* for AM

- Methods
- Analysis







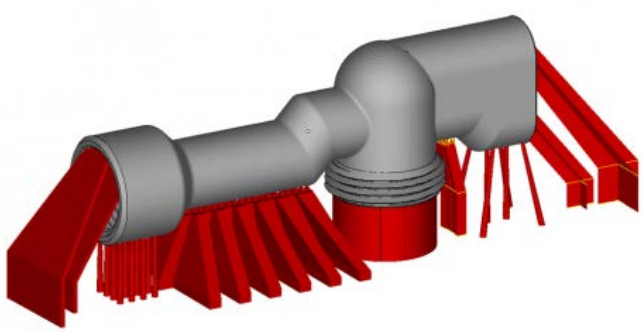


caxman

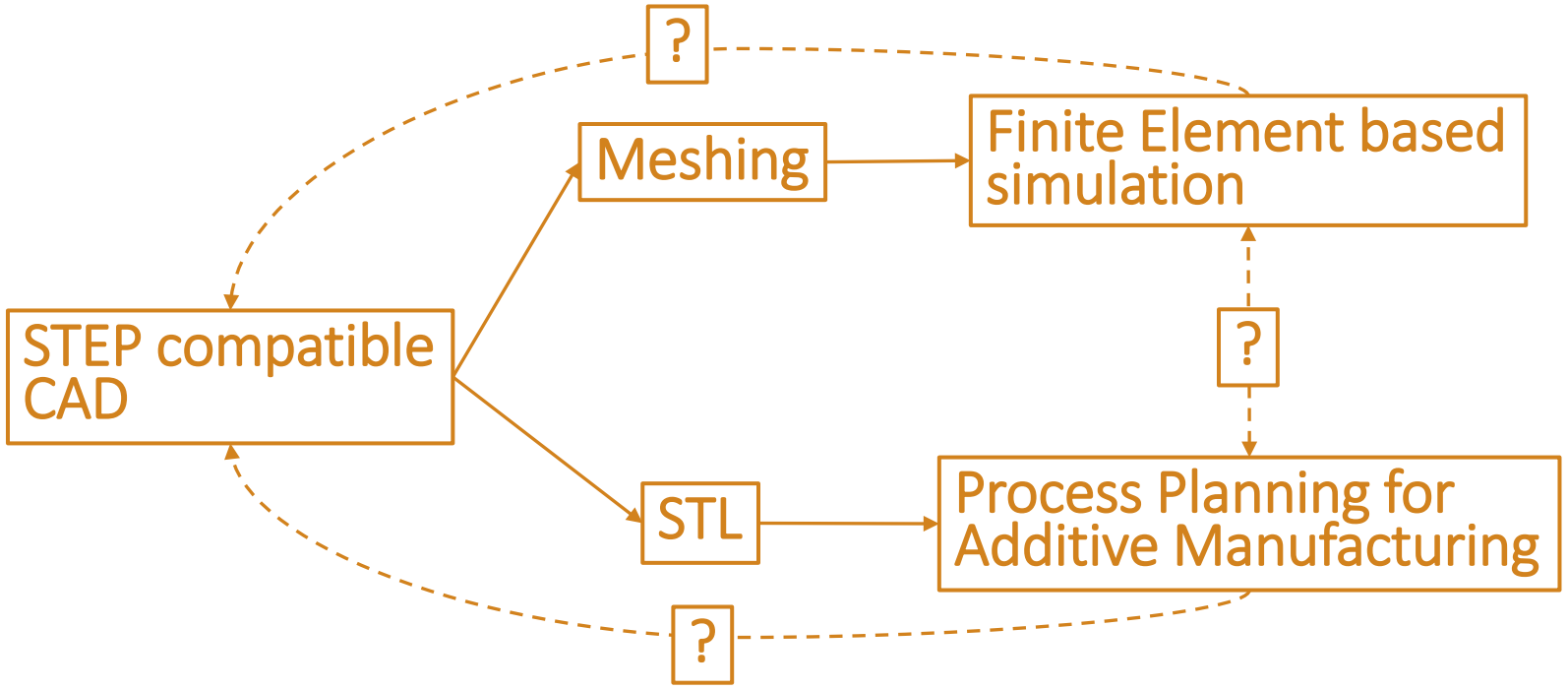
Fraunhofer IGD

Immediate challenges to CAx* for AM

- Methods
- Production



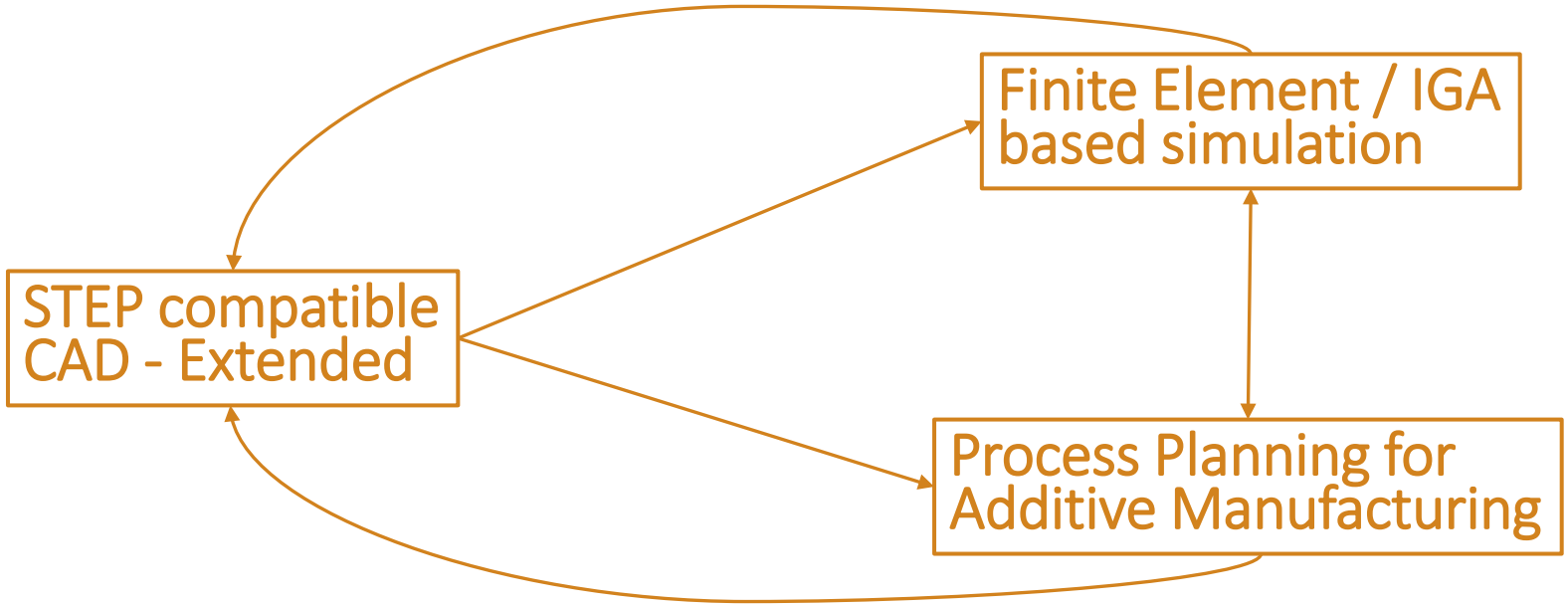
State-of-the-art information flow: CAD to Finite Elements and Additive Manufacturing



- Meshing and STL conversion reduce shape quality
- Updating CAD-models from modified mesh/STL a challenge
- Different areas of competences with weak information interoperability

Horizon 2020 Grant Agreement Number 680448

CAxMan vision: Interoperability between CAD, FEA and AM



- CAD extended with novel 3-variate isogeometric analysis extensions in ISO-103030 (STEP)
- Isogeometric Analysis or FEA harvesting 3-variate CAD
- AM extensions to STEP Part 242 Edition 2

Horizon 2020 Grant Agreement Number 680448

Complex to extend current CAD-systems with novel representations

- The resent Isogeometric extensions of STEP* (ISO 10303) add 3-variate (mathematical volumetric) representations to STEP in the shape of
  - Locally Refined B-splines (Spline space approach to local refinement of splines, guaranteeing nested spline spaces)
  - T-splines (control mesh/algorithmic approach to local refinement of splines)
- Current CAD-systems are based on B-reps a 2-variate (mathematical surface) representation and cannot be expected to include the new possibilities in foreseeable future (legacy of models and software)

caxman

* Proposed by fp7 FoF STREP TERRIFIC (2011-2014)

Horizon 2020 Grant Agreement Number 680448

The title of the H2020 FoF* CAxMan, is the title of this talk

The ambition of CAxMan is to break down the STL wall by:

- Providing a 3-variate design representation suited for analysis based design supporting complex inner structures, support structures, and variable/anisotropic material
  - Locally Refined Splines (Recent ISO 10303 STEP extension)
  - Subdivison volumes for design of inner voids and cavities
  - Design models IGA compatible, can be harvested for FEM
- Design interoperable with process planning and thermal simulation of AM
- Provide a Cloud Platform and Cloud services in the form of workflows of applications and services addressing analysis based design, process planning and thermal simulation
- Provide an ecosystem of algorithms for AM (Open Software)
- Contribute to standardization on AM (ISO 10303 –STEP)

caxman

* FoF – Factories of the Future an EU Public Private Partnership (PPP)

CAxMan provides results as Cloud services

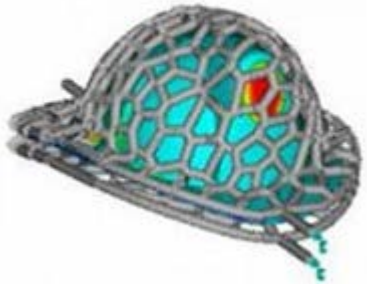
The Cloud facilitates direct distribution of new services, applications and workflows directly to the end user (e.g., SMEs) without software installation on the web browser of client device (VCN an option as well).

- CAxMan builds on the fp7 IP CloudFlow (2013-2017) and its Cloud infrastructure, and selected services, applications and workflows from CloudFlow such as Product Lifecycle Management (PLM)
- CloudFlow addresses HPC Cloud Services for small and medium sized enterprises and includes 6 internal and 14 external experiments selected after two rounds of Open Calls.
  - Originally 11 partners
  - Extended to 46 partners following external calls for new experiments in 2014 and 2015
  - Total EU-funding: 6.6 M€ (2M€ for the external calls)
  - www.cloudflow.eu

caxman

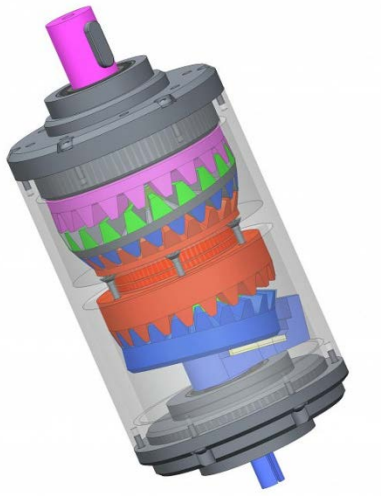
Horizon 2020 Grant Agreement Number 680448

CAxMan Use Case partners



Injection molds cooling system (France)

NOVATRA



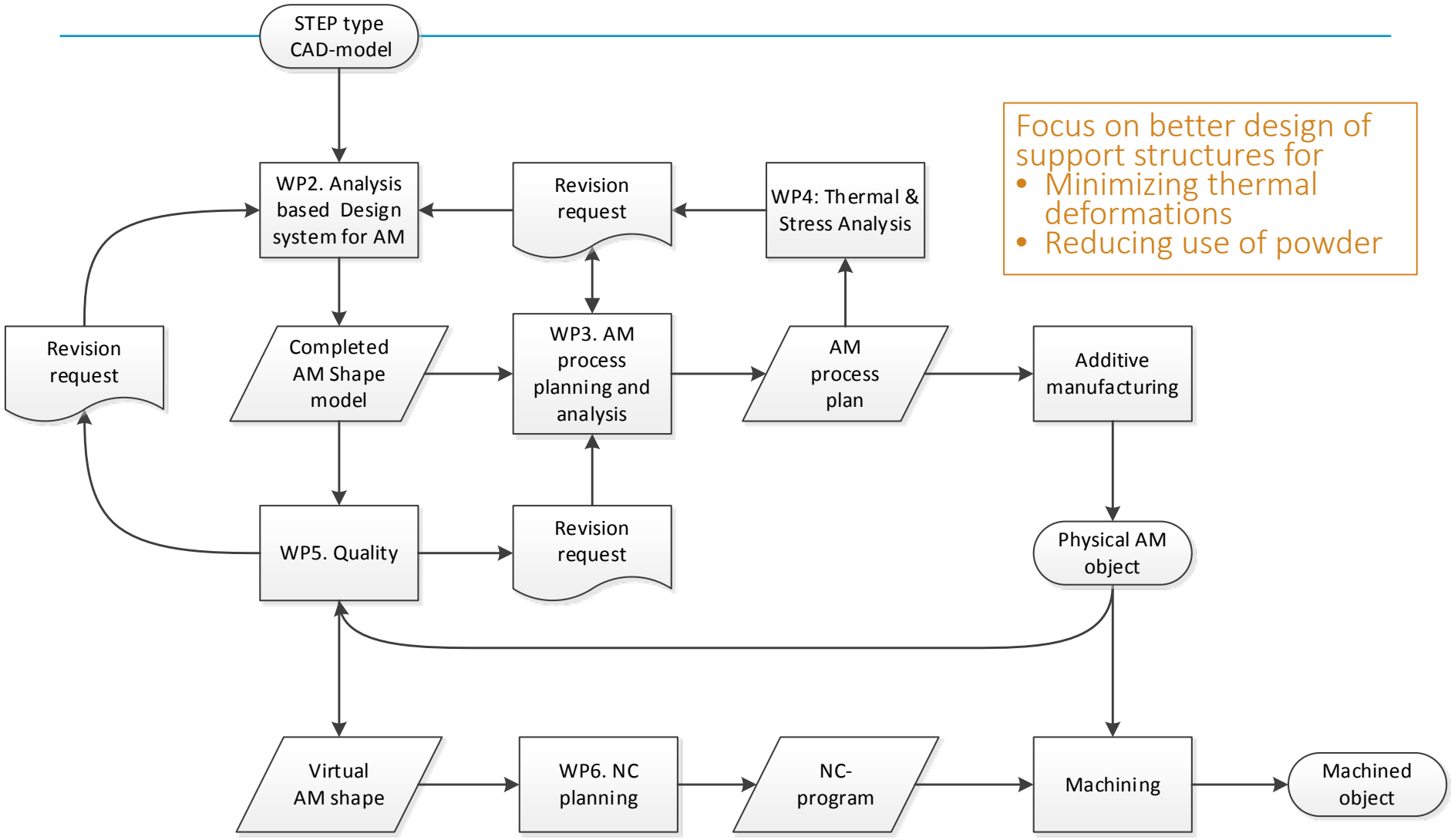
Special gear box (Italy)

Stam

caxman

Horizon 2020 Grant Agreement Number 680448

OVERALL CAxMan IDEA



Focus on better design of support structures for
- Minimizing thermal deformations
- Reducing use of powder

Horizion 2020 Grant Agreement Number 680448

CAxMan does not address all aspects

Topology optimization

CAxMan

Analysis based design for AM

AM process planning

AM material material aspects
- Metal
- Polymer
- ….

Horizon 2020 Grant Agreement Number 680448

CAxMan - Facts

- Duration: September 1, 2015 – August 31, 2018
- EU-contribution: 7,143,300€
- Effort: 748 Person Months
- Coordinator: SINTEF, Norway (Tor Dokken)
- Partners from
  - Austria: 1
  - France: 2
  - Germany: 2
  - Italy: 2
  - Norway: 3
  - Slovenia: 1
  - Spain: 2

Horizon 2020 Grant Agreement Number 680448

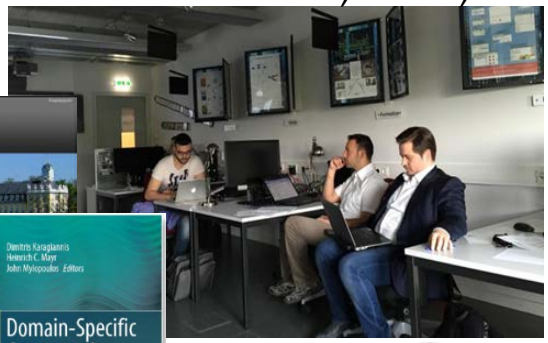
Partners – European Dimension

caxman

Horizon 2020 Grant Agreement Number 680448

Impressions of ADOxx.org

ADOxx – OMiLAB
Summer School, Book, …



John A. Zachmann will come to OMiLAB Summer School

ADOxx.org at Conferences

JOIN ADOxx.org

ADOxx – Trainings

3rd Party Communities talk about ADOxx

Prof. Lee, Chonbuk University: „Best Paper with ADOxx solution“

EU Project collaboration on ADOxx.org

CloudSocket
OrbEEt
caxman
computer aided technologies for additive manufacturing
adapt4ee
Bivee
MODAClouds
e-SAVE
. . .

HORIZON 2020

caxman

computer aided technologies for additive manufacturing

THANK YOU FOR YOUR ATTENTION !

OMiLAB4FoF: An environment to design and develop modelling methods for the Factory of the Future

Jean Claude Morel, Missler Software
Jc.morel@topsolid.com

http://www.CAxman.eu
09/2015-08/2018.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680448