GREENDELTA

sustainability consulting + software

OPENLCA

LCA4Sim - Bringing CADMOULD and openLCA together to facilitate predictive life cycle assessments in the injection moulding industry

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Project Information - LCA4Sim

Project title:	Ökobilanzierung in der Spritzguss-Simulation (Life Cycle Assessment in Injection Molding Simulation)
Acronym:	LCA4Sim
Runtime:	01.07.2021 bis 30.06.2024
Promotion:	Bundesministerium für Bildung und Forschung (BMBF)
Project Executive Organisation:	Projektträger Jülich (PTJ)
Funding code:	031B1242

Bundesministerium für Bildung und Forschung

Projektträger Jülich
Forschungszentrum Jülich

LCA4Sim – Project partners

SIMCON

IfBB
Institute for Bioplastics and Biocomposites

Fraunhofer WKI

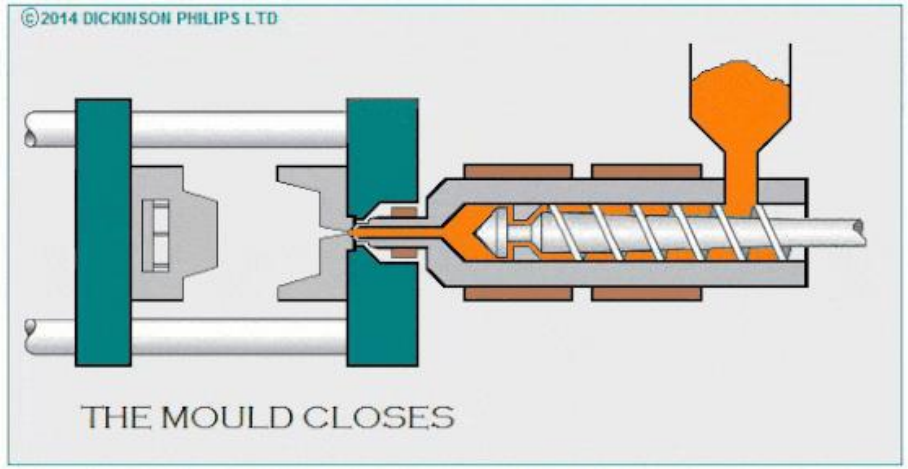
bekuplast

GreenDELTa

Introduction – Injection moulding

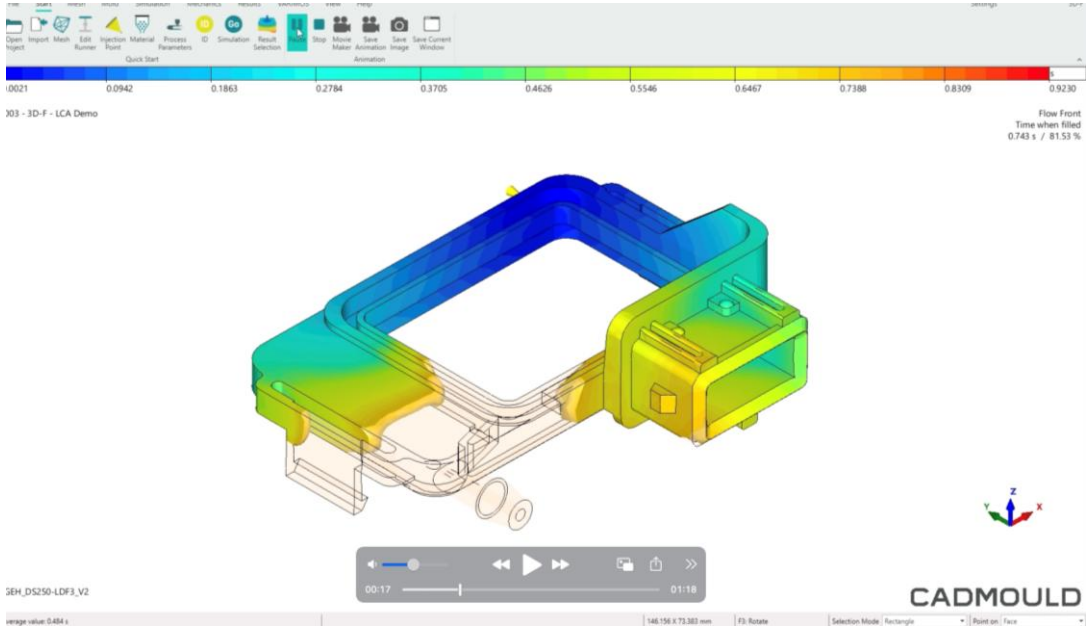
- The polymer manufacturing industry has been experiencing rapid growth of 363.8 million tons globally from 1976 to 2023 due to increasing global demand for polymer-based products (Statista, 2024)

- The injection moulding process is a polymer-processing method that is used in a wide range of applications.
  - Its major advantages lie in the high degree of design freedom of the tools used and thus of the resulting components as well as in the high throughput potential for manufacturers.

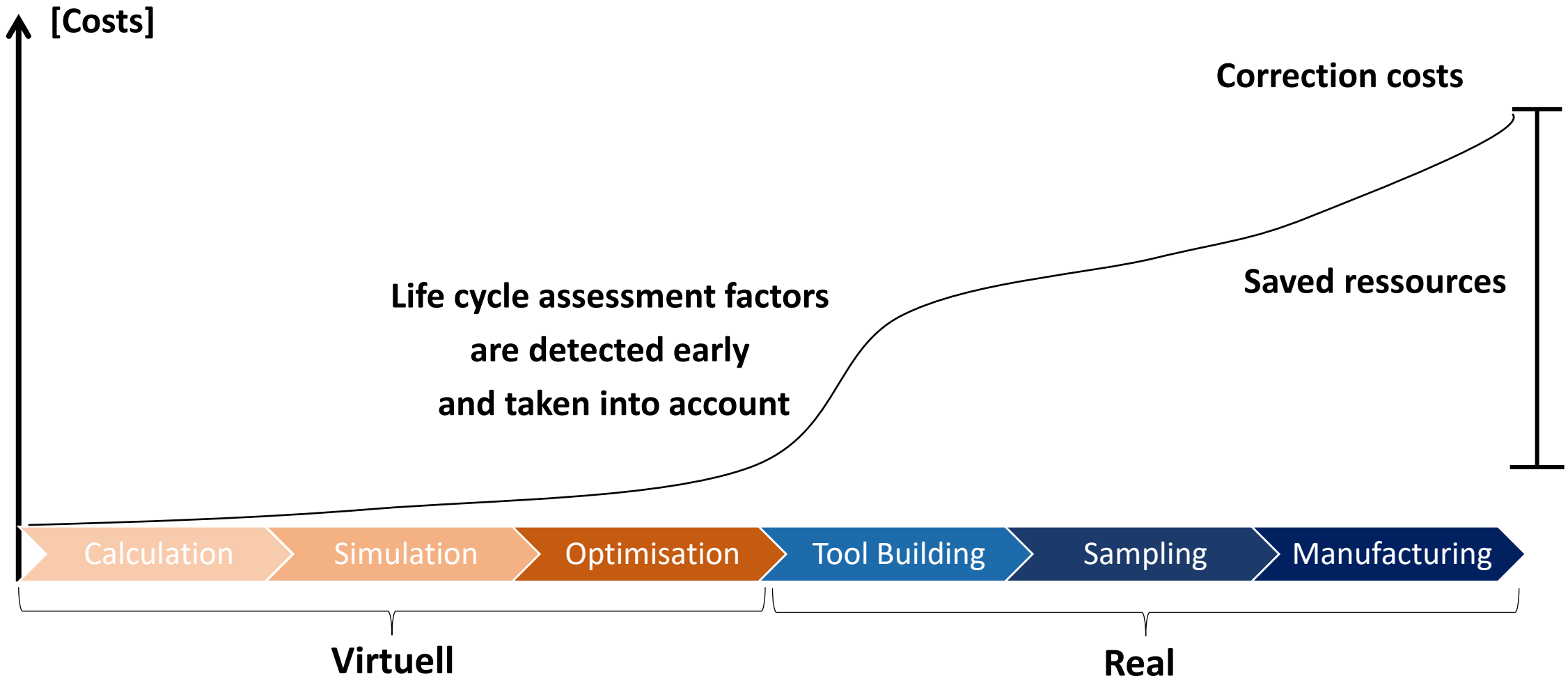


Introduction - Simulation Software

- Process control is an important aspect, especially for the implementation of injection moulding on an industrial scale, since the various parameters have a major influence on the quality of the components and process stability, but also a strong impact on energy consumption.
- The optimization of process control can be achieved using simulation software such as CADMOULD (by SIMCON)



Cost avoidance through early life cycle assessment optimisation

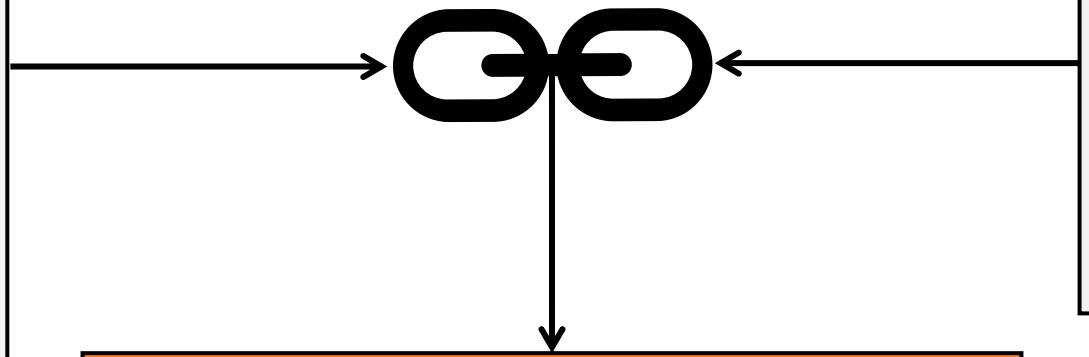


Interface CADMOULD and openLCA

CADMOULD & VARIMOS

openLCA

Injection Moulding Simulation
- Material influence
- Post-pressure simulation
- Energy consumption
- Distortion simulation
- Parameter variation

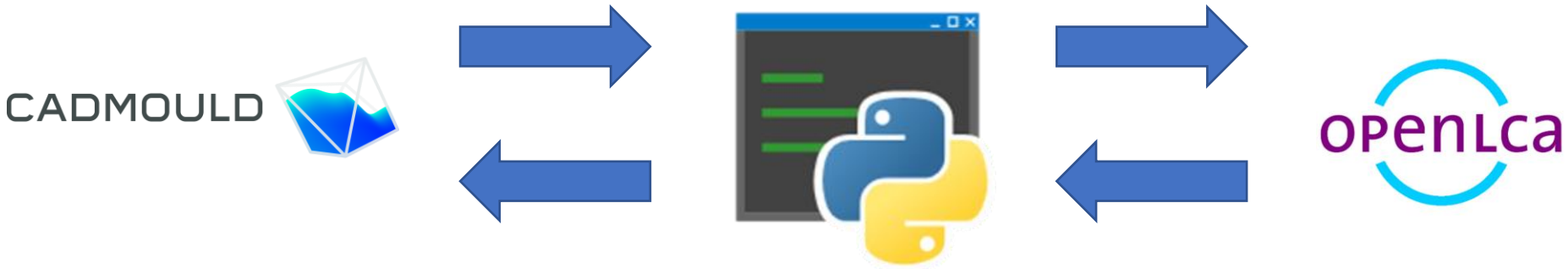


Life cycle assessment
- Database Integration
- Products & Processes
- Carbon footprint
- Energy consumption
- Transport

LCA4Sim – injection moulding simulation, but sustainable

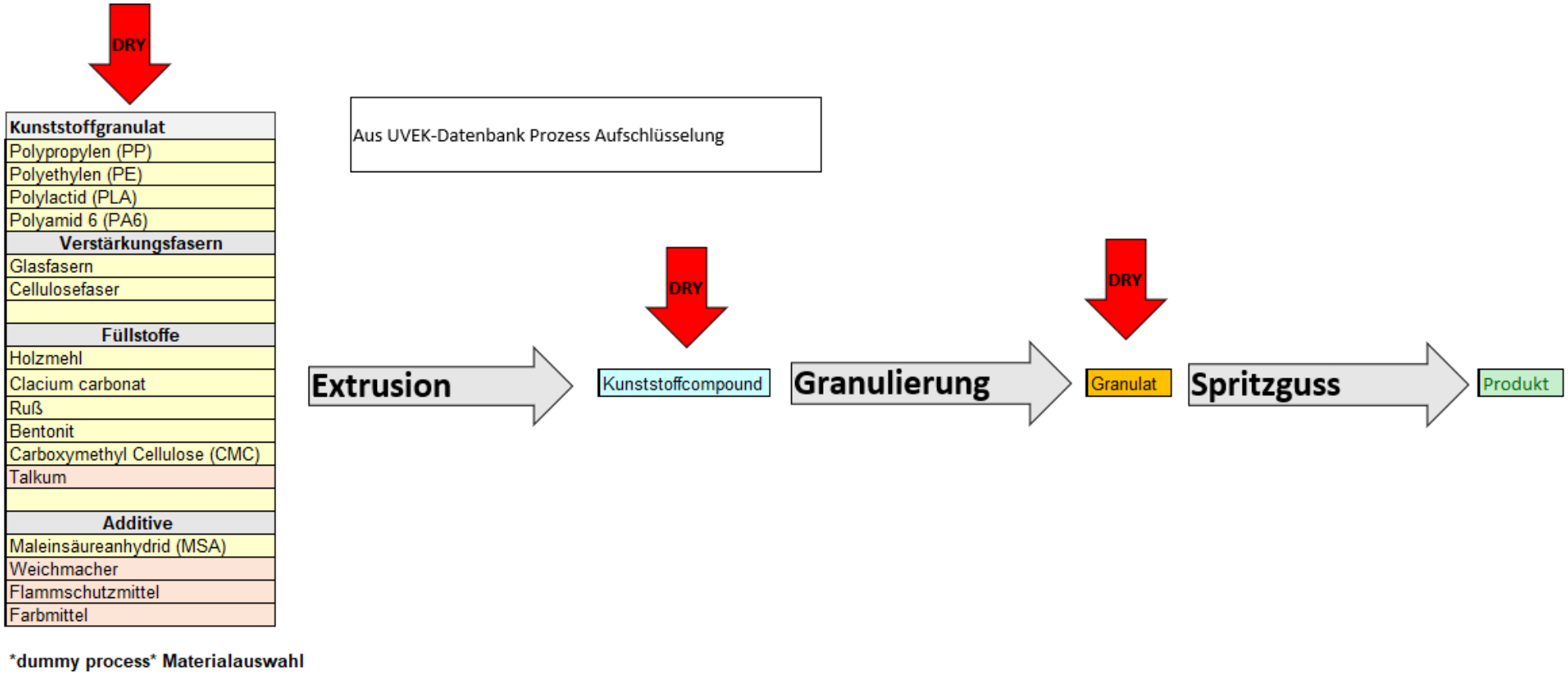
Interface CADMOULD and openLCA

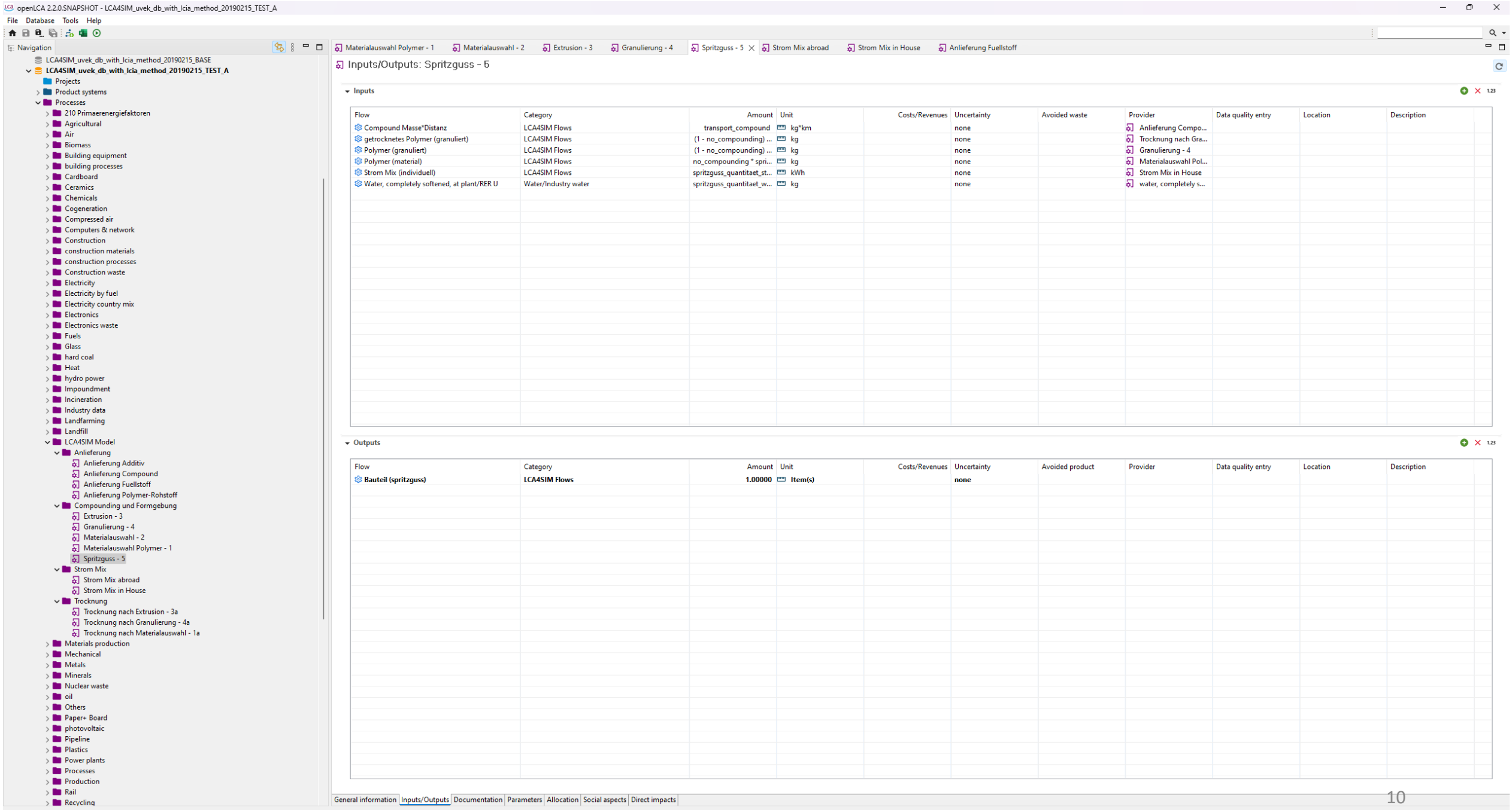
- In order to enable communication between CADMOULD and openLCA, it was necessary to implement a client skip that can extract, convert and insert data from both software applications.
- To make this possible, a client script was written which was integrated into CADMOULD.

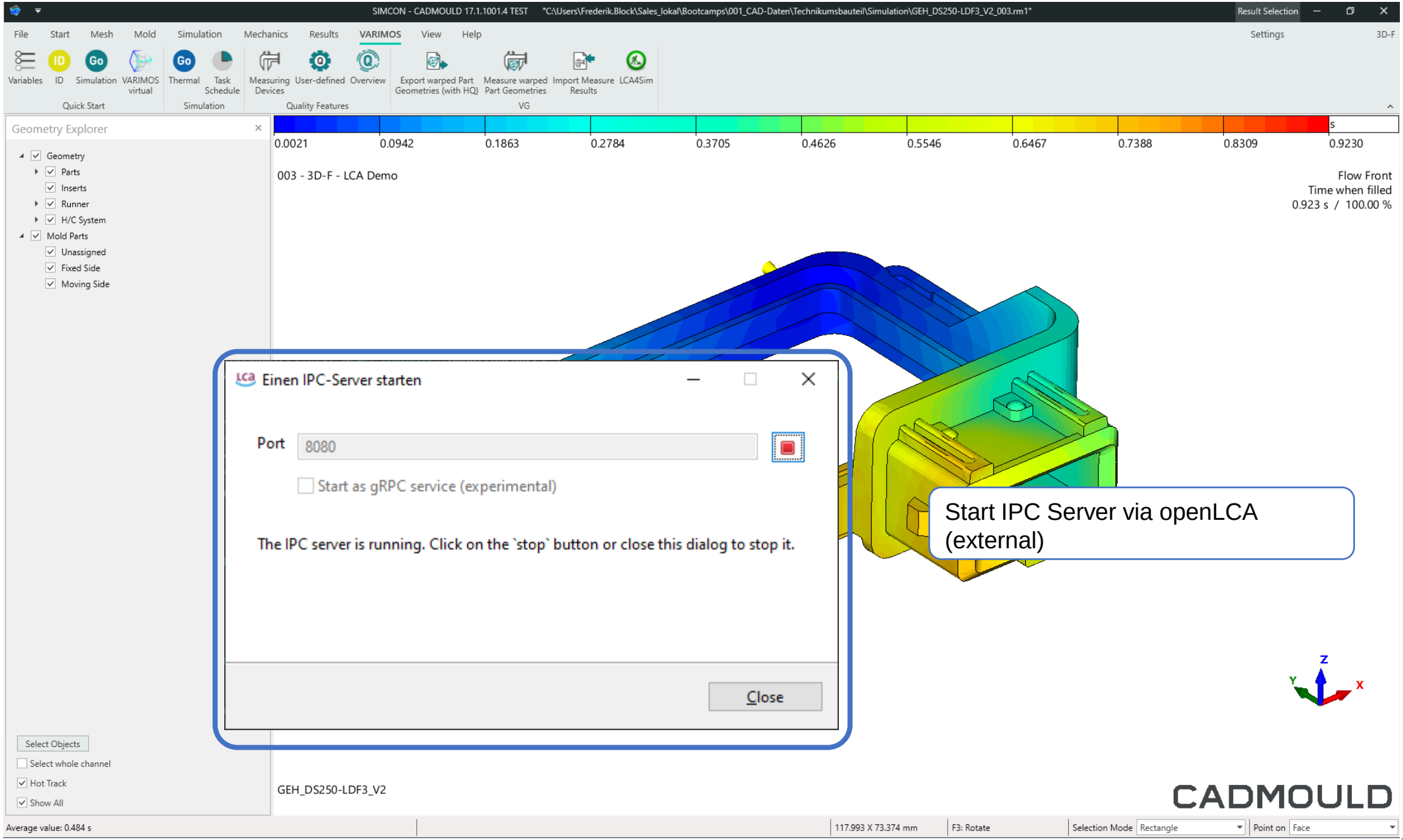


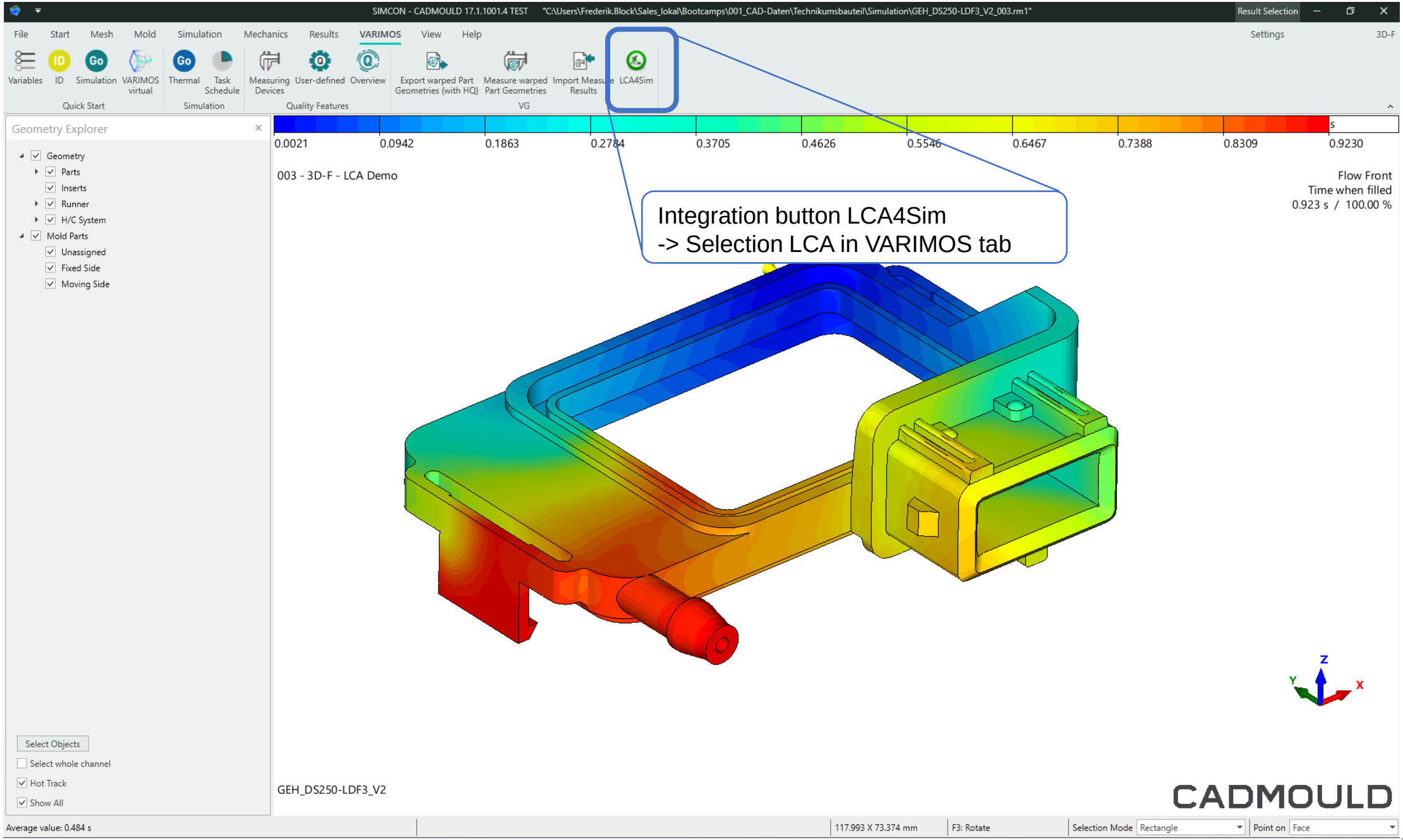
Model Setup

- A cradle-to-gate approach was used.




openLCA 2.2.0.SNAPSHOT - LCA4SIM_uvek_db_with_lcia_method_20190215_TEST_A
File Database Tools Help
Navigation
LCA4SIM_uvek_db_with_lcia_method_20190215_BASE
LCA4SIM_uvek_db_with_lcia_method_20190215_TEST_A
Projects
Product systems
Processes
210 Primaerenergiefaktoren
Agricultural
Air
Biomass
Building equipment
building processes
Cardboard
Ceramics
Chemicals
Cogeneration
Compressed air
Computers & network
Construction
construction materials
construction processes
Construction waste
Electricity
Electricity by fuel
Electricity country mix
Electronics
Electronics waste
Fuels
Glass
hard coal
Heat
hydro power
Impoundment
Incineration
Industry data
Landfarming
Landfill
LCA4SIM Model
Anlieferung
Anlieferung Additiv
Anlieferung Compound
Anlieferung Fuellstoff
Anlieferung Polymer-Rohstoff
Compounding und Formgebung
Extrusion - 3
Granulierung - 4
Materialauswahl - 2
Materialauswahl Polymer - 1
Spritzguss - 5
Strom Mix
Strom Mix abroad
Strom Mix in House
Trocknung
Trocknung nach Extrusion - 3a
Trocknung nach Granulierung - 4a
Trocknung nach Materialauswahl - 1a
Materials production
Mechanical
Metals
Minerals
Nuclear waste
oil
Others
Paper+ Board
photovoltaic
Pipeline
Plastics
Power plants
Processes
Production
Rail
Recycling
Materialauswahl Polymer - 1
Materialauswahl - 2
Extrusion - 3
Granulierung - 4
Spritzguss - 5
Strom Mix abroad
Strom Mix in House
Anlieferung Fuellstoff
Inputs/Outputs: Spritzguss - 5
Inputs
Flow | Category | Amount | Unit | Costs/Revenues | Uncertainty | Avoided waste | Provider | Data quality entry | Location | Description
Compound Masse*Distanz | LCA4SIM Flows | transport_compound | kg*km | | none | | Anlieferung Compo...
getrocknetes Polymer (granuliert) | LCA4SIM Flows | (1 - no_compounding) ... | kg | | none | | Trocknung nach Gra...
Polymer (granuliert) | LCA4SIM Flows | (1 - no_compounding) ... | kg | | none | | Granulierung - 4
Polymer (material) | LCA4SIM Flows | no_compounding * spri... | kg | | none | | Materialauswahl Pol...
Strom Mix (individuell) | LCA4SIM Flows | spritzguss_quantitaet_st... | kWh | | none | | Strom Mix in House
Water, completely softened, at plant/RER U | Water/Industry water | spritzguss_quantitaet_w... | kg | | none | | water, completely s...
Outputs
Flow | Category | Amount | Unit | Costs/Revenues | Uncertainty | Avoided product | Provider | Data quality entry | Location | Description
Bauteil (spritzguss) | LCA4SIM Flows | 1.00000 | Item(s) | | none
General information Inputs/Outputs Documentation Parameters Allocation Social aspects Direct impacts


SIMCON - CADMOULD 17.1.1001.4 TEST "C:\Users\Frederik.Block\Sales_lokal\Bootcamps\001_CAD-Daten\Technikumsbauteil\Simulation\GEH_DS250-LDF3_V2_003.rm1"
Result Selection
File Start Mesh Mold Simulation Mechanics Results VARIMOS View Help
Settings 3D-F
Variables ID Simulation VARIMOS virtual Thermal Task Schedule Measuring Devices User-defined Overview Export warped Part Geometries (with HQ) Measure warped Part Geometries Import Measure Results LCA4Sim
Quick Start Simulation Quality Features VG
Geometry Explorer
Geometry
Parts
Inserts
Runner
H/C System
Mold Parts
Unassigned
Fixed Side
Moving Side
0.0021 0.0942 0.1863 0.2784 0.3705 0.4626 0.5546 0.6467 0.7388 0.8309 0.9230 s
003 - 3D-F - LCA Demo
Flow Front
Time when filled
0.923 s / 100.00 %
Einen IPC-Server starten
Port 8080
Start as gRPC service (experimental)
The IPC server is running. Click on the `stop` button or close this dialog to stop it.
Close
Start IPC Server via openLCA (external)
Z Y X
Select Objects
Select whole channel
Hot Track
Show All
GEH_DS250-LDF3_V2
CADMOULD
Average value: 0.484 s
117.993 X 73.374 mm
F3: Rotate
Selection Mode Rectangle
Point on Face


SIMCON - CADMOULD 17.1.1001.4 TEST "C:\Users\Frederik.Block\Sales_lokal\Bootcamps\001_CAD-Daten\Technikumsbauteil\Simulation\GEH_DS250-LDF3_V2_003.rm1"
Result Selection
File Start Mesh Mold Simulation Mechanics Results VARIMOS View Help
Settings 3D-F
Variables ID Simulation VARIMOS virtual Thermal Task Schedule Measuring Devices User-defined Overview Export warped Part Geometries (with HQ) Measure warped Part Geometries Import Measure Results LCA4Sim
Quick Start Simulation Quality Features VG
Geometry Explorer
Geometry
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Inserts
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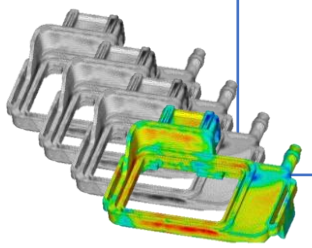
H/C System
Mold Parts
Unassigned
Fixed Side
Moving Side
0.0021 0.0942 0.1863 0.2784 0.3705 0.4626 0.5546 0.6467 0.7388 0.8309 0.9230 s
003 - 3D-F - LCA Demo
Flow Front
Time when filled
0.923 s / 100.00 %
Integration button LCA4Sim
-> Selection LCA in VARIMOS tab
Z
Y
X
Select Objects
Select whole channel
Hot Track
Show All
GEH_DS250-LDF3_V2
CADMOULD
Average value: 0.484 s
117.993 X 73.374 mm
F3: Rotate
Selection Mode Rectangle
Point on Face

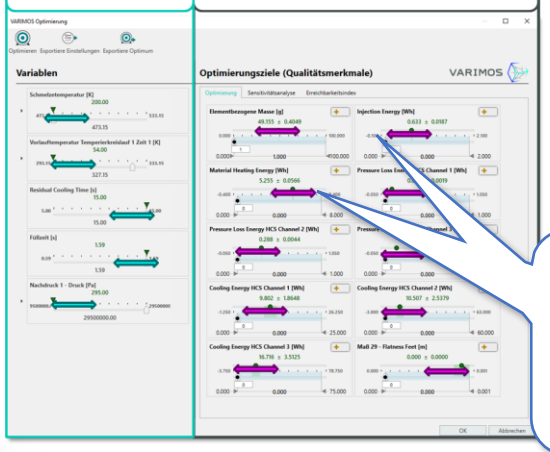
Definition of production environment (country, electricity mix used, transportation, etc.)

Data from simulations carried out

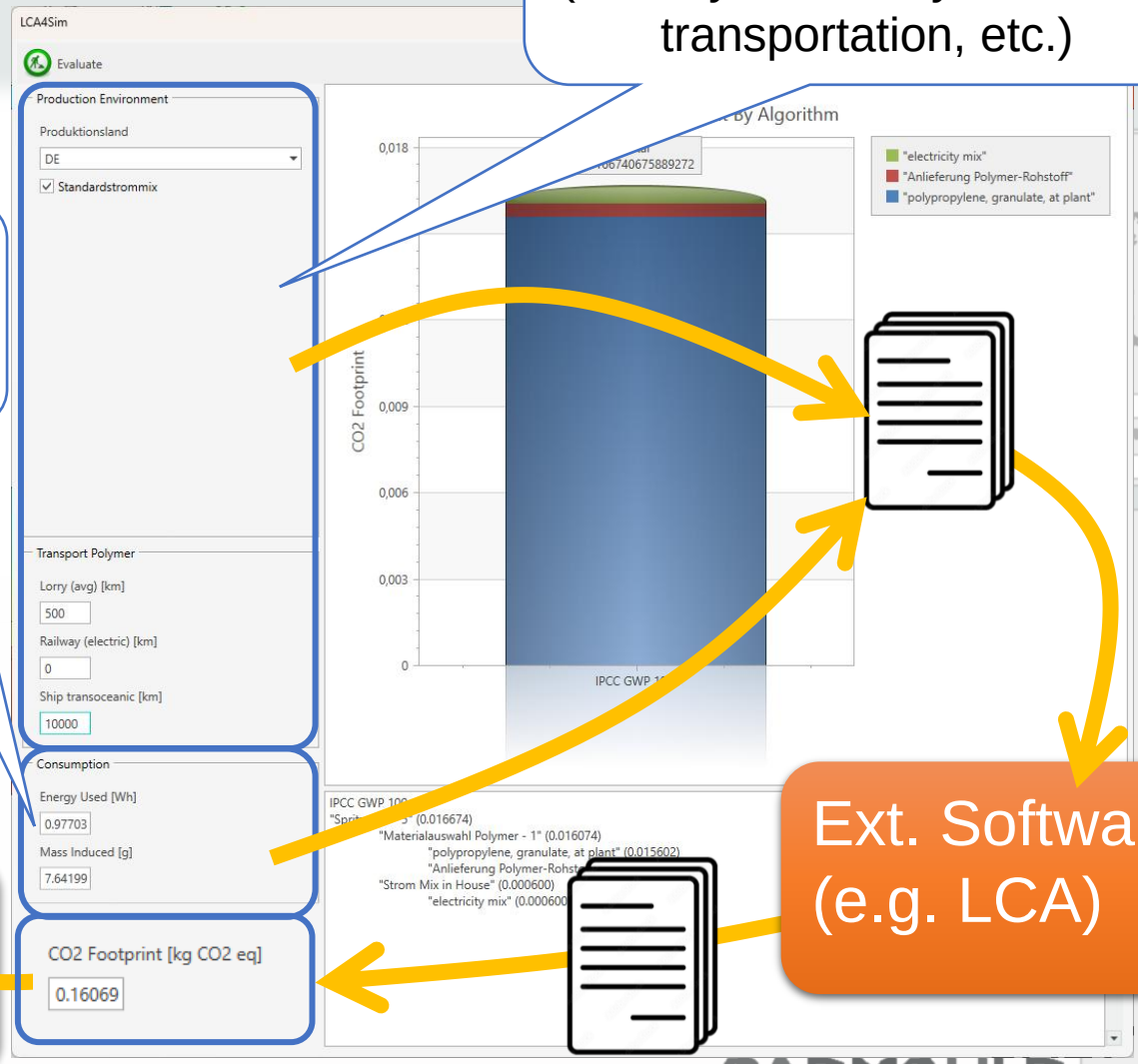


Cause

Effect

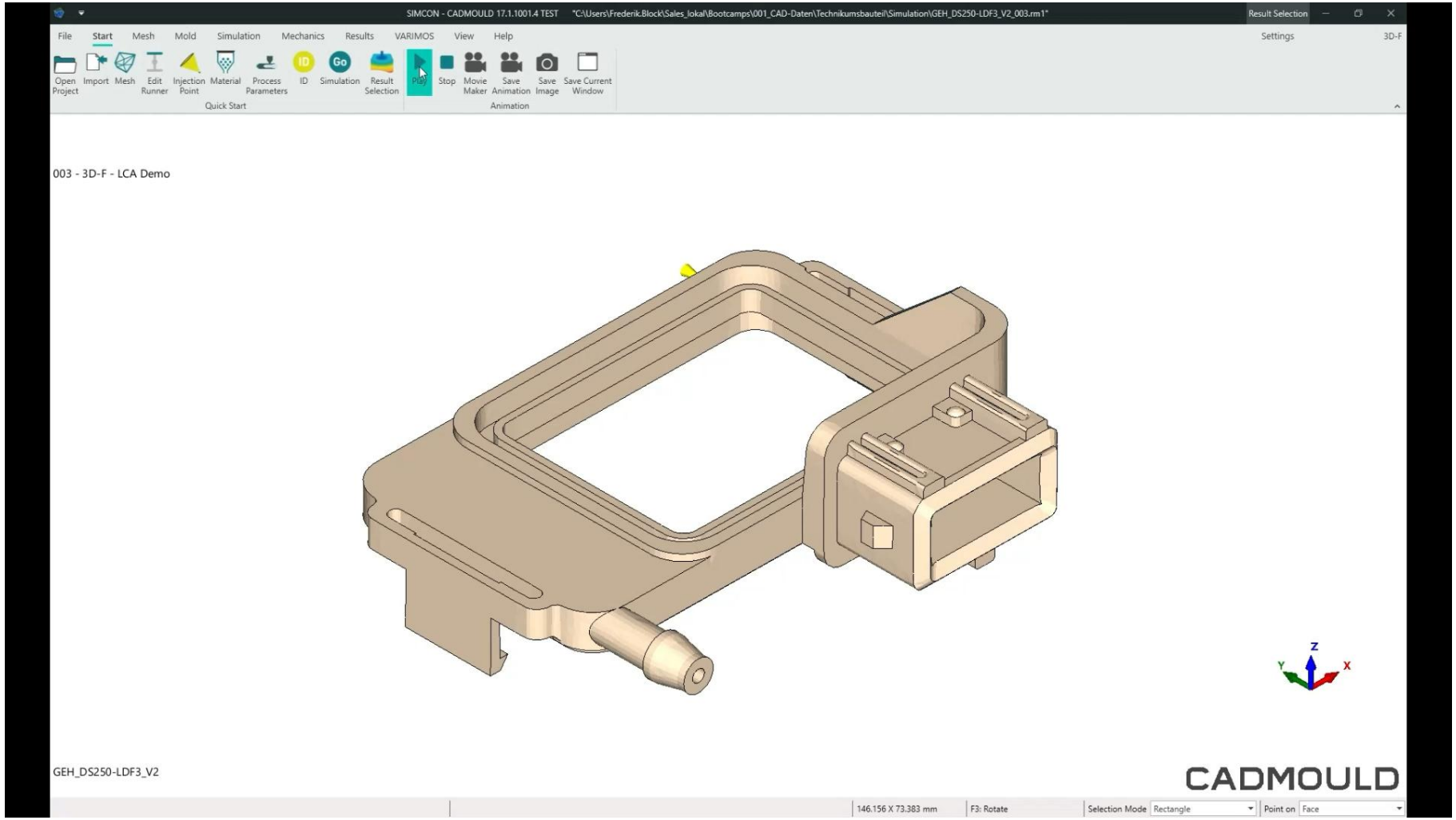


Traceability to target values



Ext. Software (e.g. LCA)

Animation


SIMCON - CADMOULD 17.1.1001.4 TEST
Result Selection
File
Start
Mesh
Mold
Simulation
Mechanics
Results
VARIMOS
View
Help
Settings
3D-F
Open Project
Import
Mesh
Edit Runner
Injection Point
Material
Process Parameters
ID
Simulation
Result Selection
Play
Stop
Movie Maker
Save Animation
Save Image
Save Current Window
Quick Start
Animation
003 - 3D-F - LCA Demo
GEH_DS250-LDF3_V2
CADMOULD
146.156 X 73.383 mm
F3: Rotate
Selection Mode
Rectangle
Point on
Face

Conclusion

- Integration of sustainability-relevant data in CADMOULD enables predictive optimization of the sustainability of polymer products.
- With the new interface (LCA4Sim button), material use, processing methods and transport routes can be mapped and simulated in CADMOULD.
- LCA4Sim shows the potential of digitalization for a sustainable polymers industry.

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Thank you very much for your attention!

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References

- Statista (2024) ‘Annual production of plastics worldwide from 1950 to 2023’ [online]: Hamburg, Statista. Available from: https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/ [accessed 27 November 2024].