Geometry Morphing and Optimization with 3D Mesh
(CP12106-P)

Sony Visual Products Inc.
Panel & Mechanical Design Department

Roger CORN

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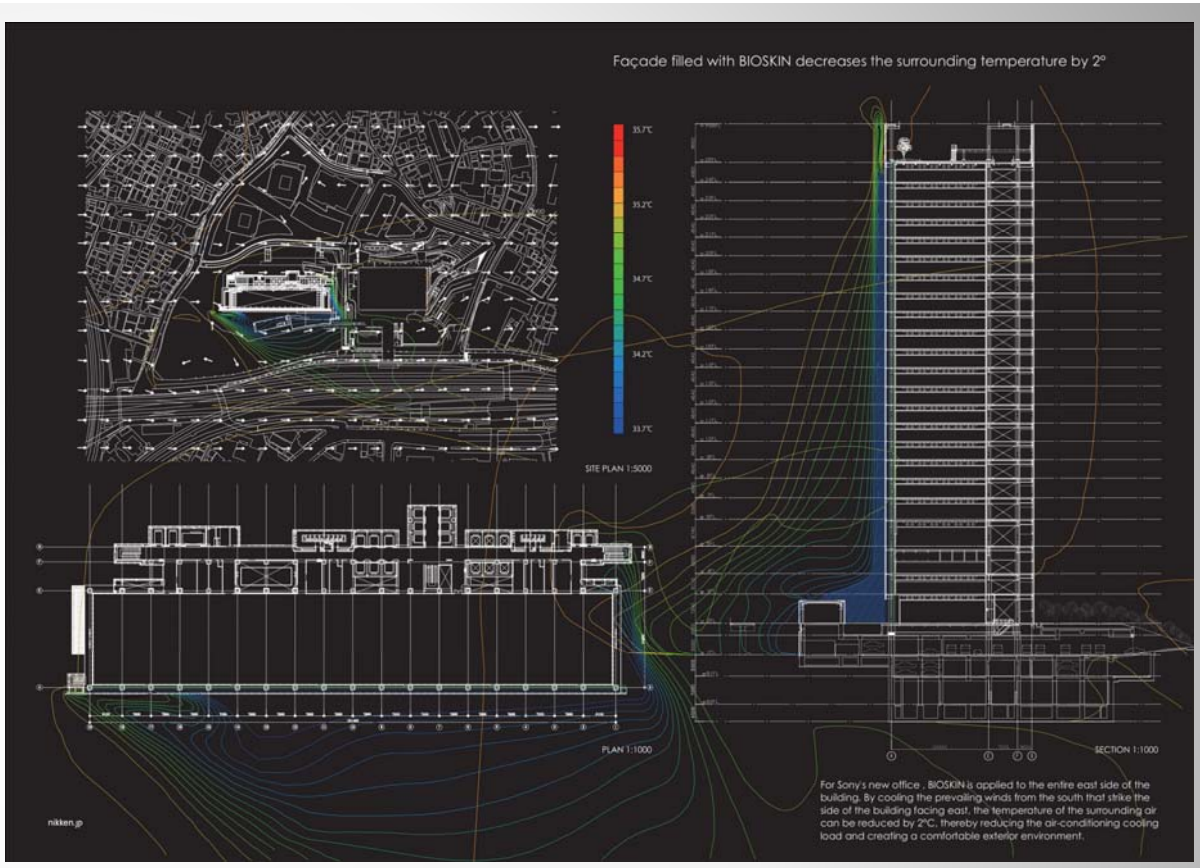
introduction

Sony Visual Products Inc.

founded : 2014.7.1
shareholders : Sony Corporation 100%
employees : approx. 750

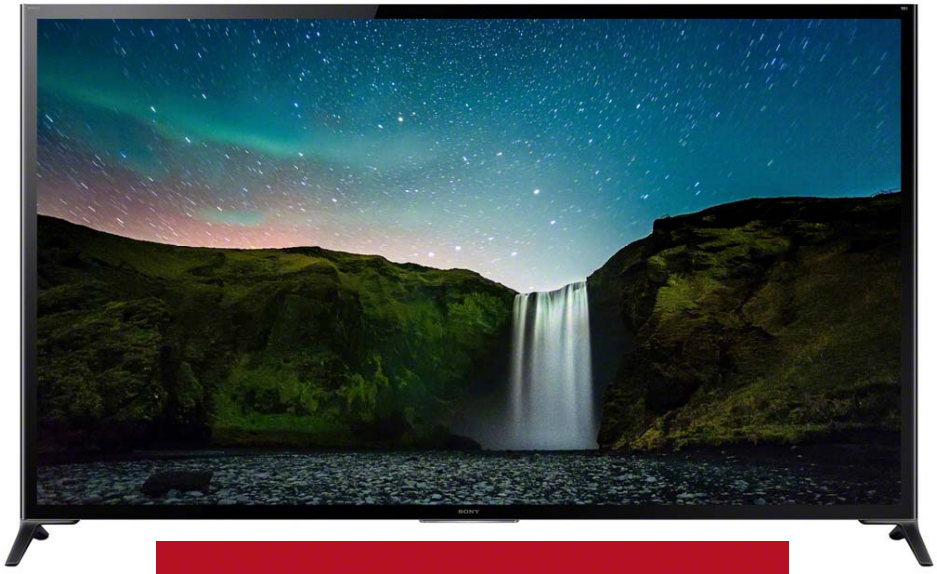
introduction



designed and built by NIKKEN using AUTODESK software …

Sony Visual Products Inc.

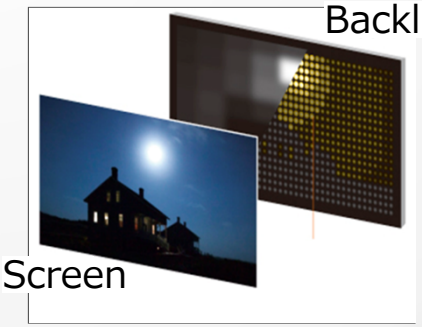
introduction



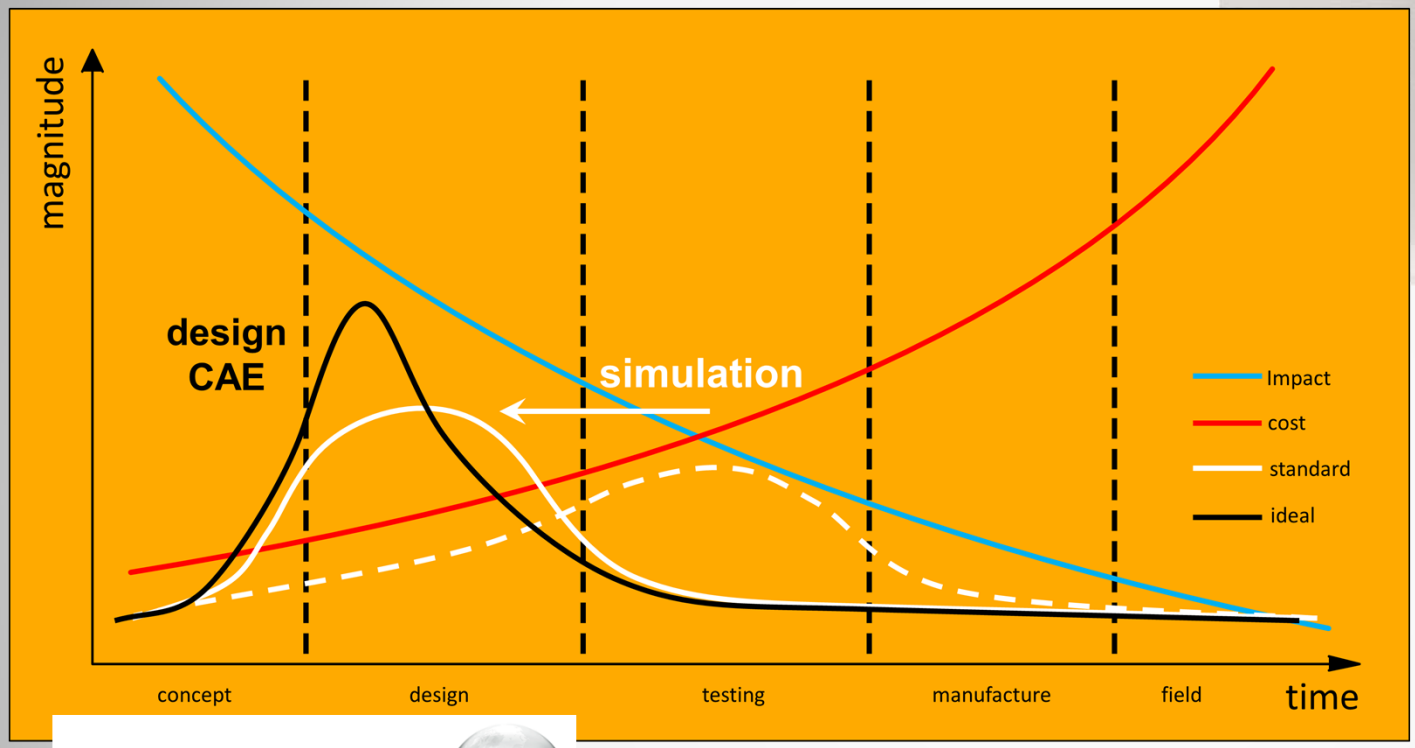
BRAVIA

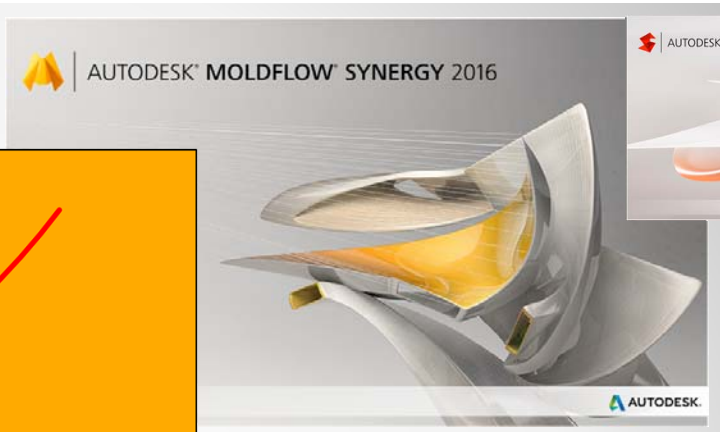
4K X-Reality PRO

X-tended Dynamic Range PRO

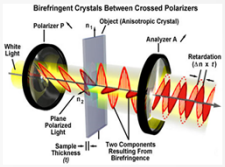


introduction

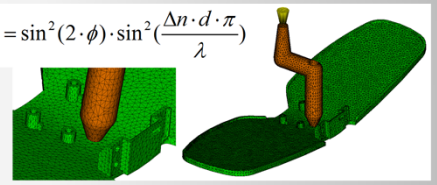


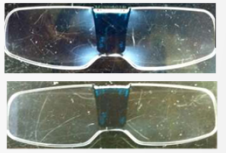


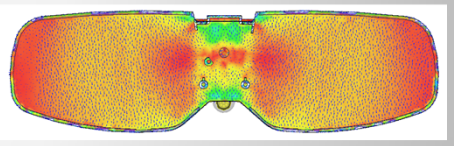
stress birefringence mitigation

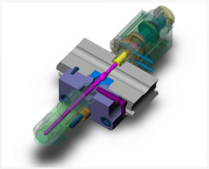


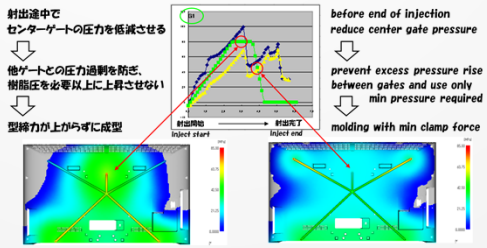
$$\frac{I}{I_0} = \sin^2(2\cdot\phi)\cdot\sin^2\left(\frac{\Delta n\cdot d\cdot\pi}{\lambda}\right)$$





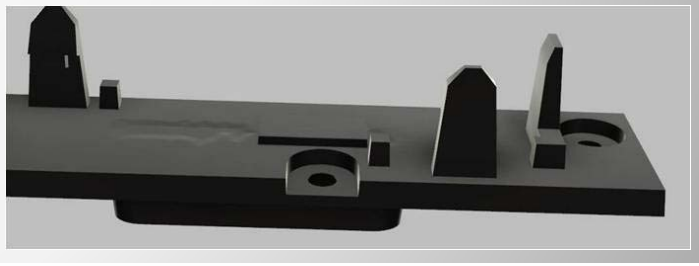


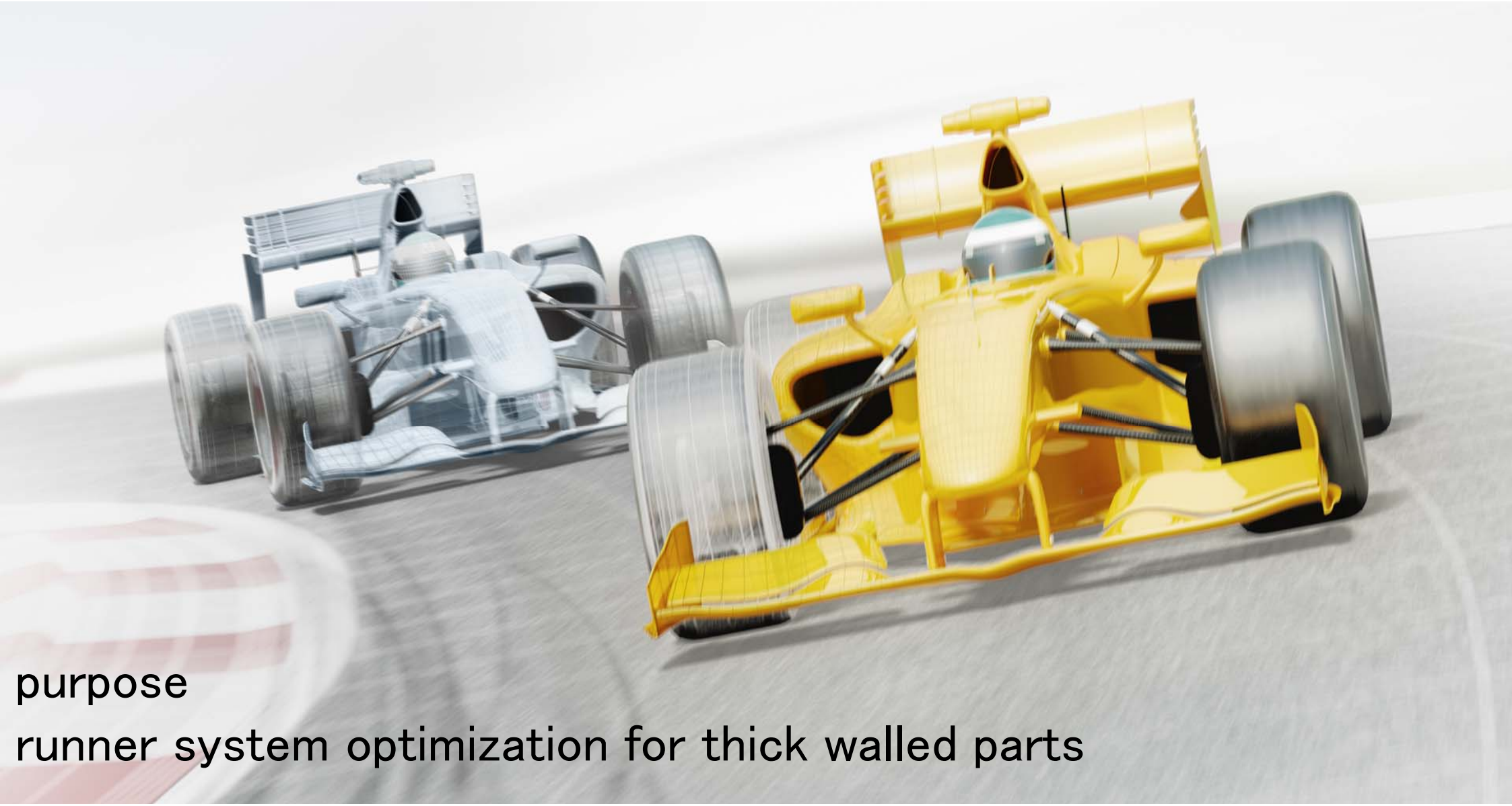




low pressure molding

sink prediction and visualization





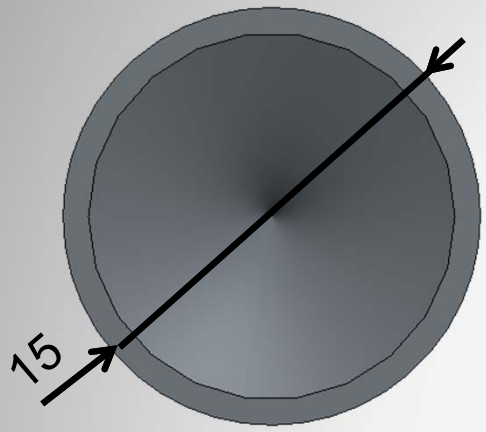
purpose

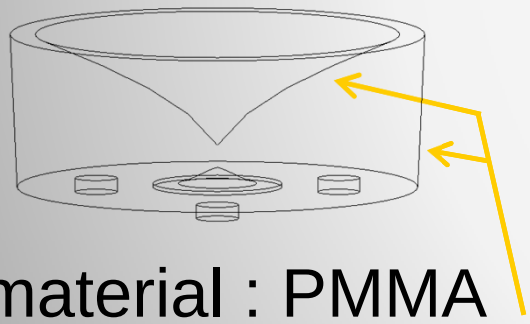
runner system optimization for thick walled parts

runner system KPI (AMI evaluation item)

function / cost

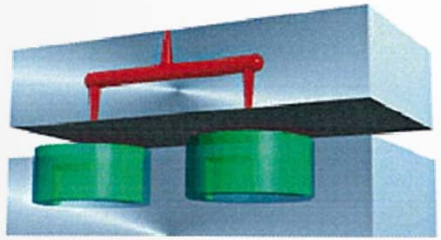
- gate vestige minimization（gate area）
- surface quality（volumetric shrinkage）
- material usage（runner volume / size）
- cavitation & capacity（cycle time）



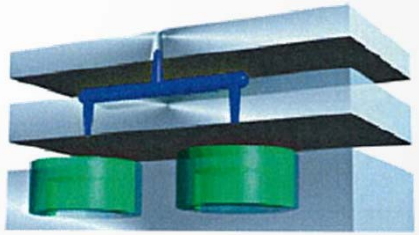


material : PMMA
weight : 0.9g

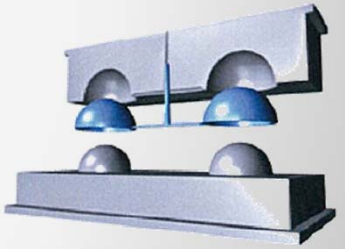
functional surface



hot runner



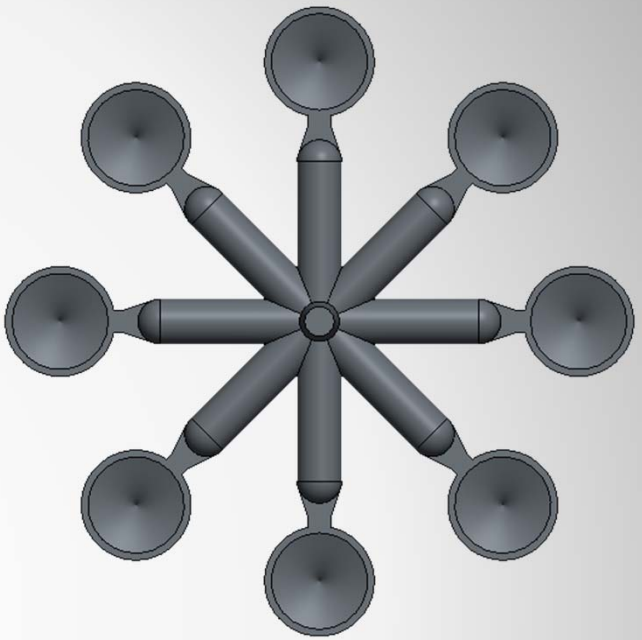
3 plate

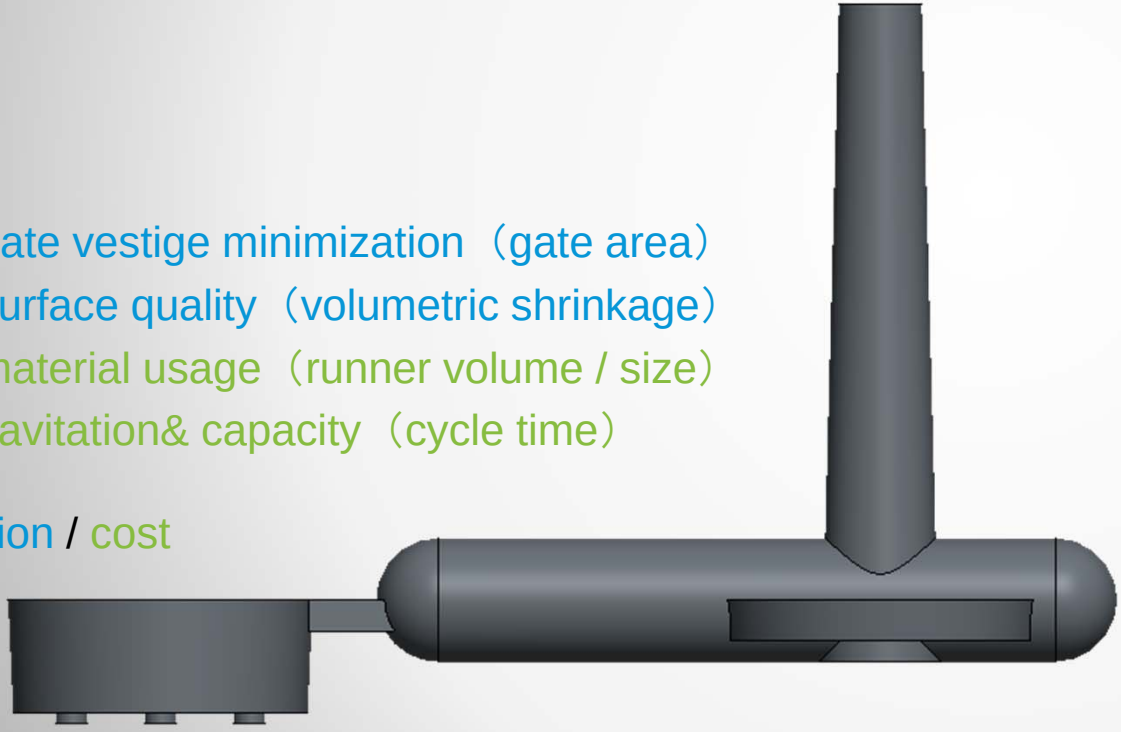


cold runner

function / cost

- gate vestige minimization（gate area）
- surface quality（volumetric shrinkage）
- material usage（runner volume / size）
- cavitation & capacity（cycle time）

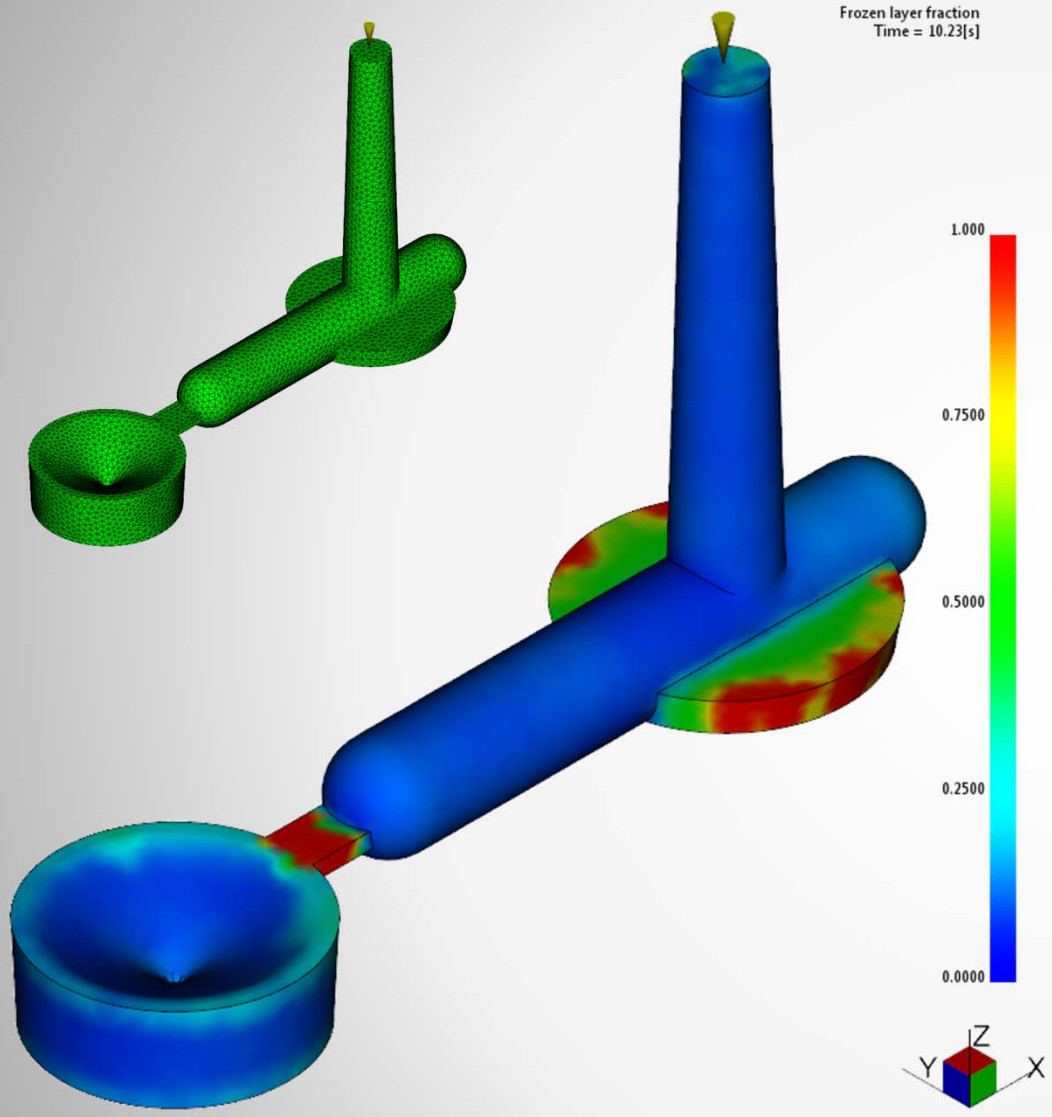


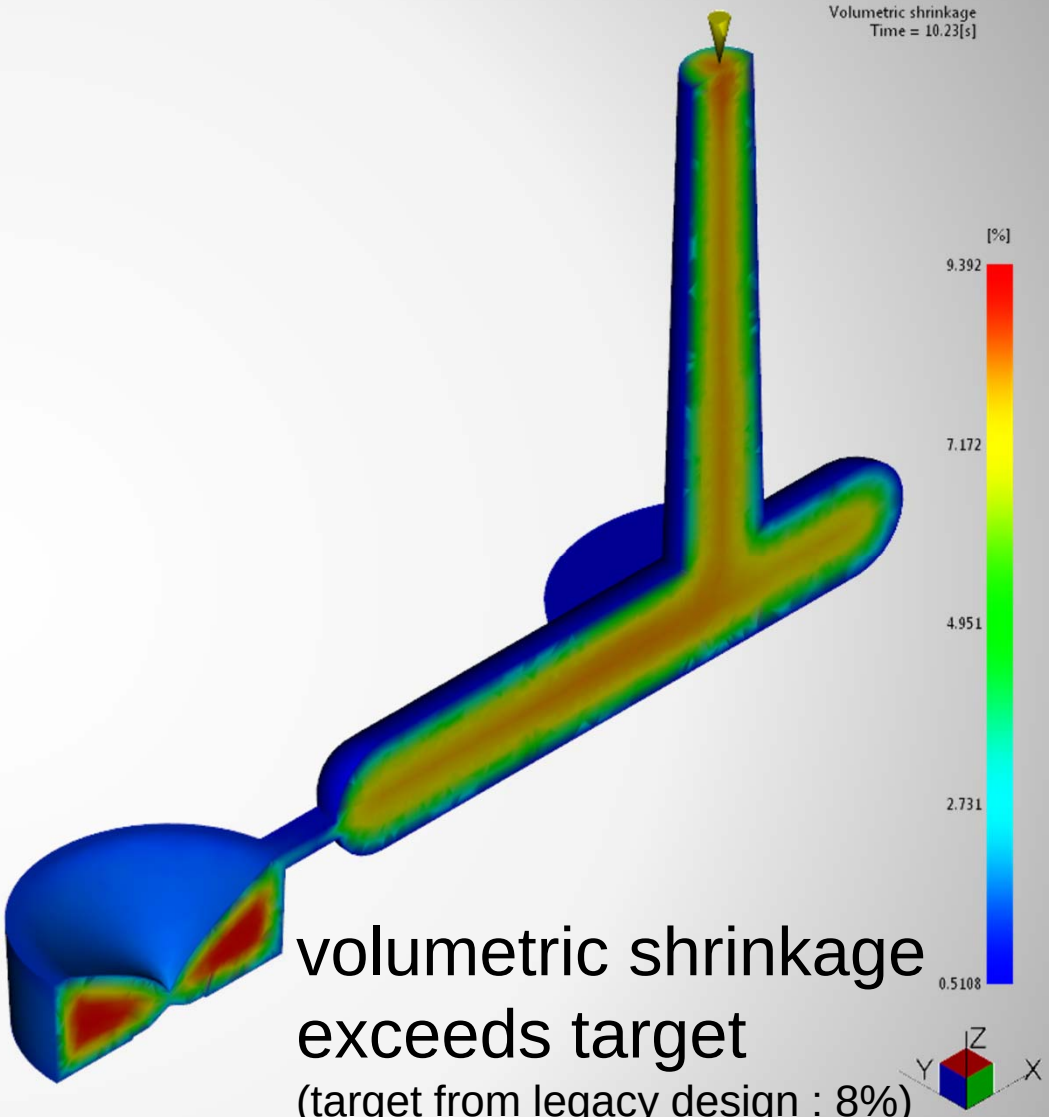


- gate vestige minimization（gate area）
- surface quality（volumetric shrinkage）
- material usage（runner volume / size）
- cavitation& capacity（cycle time）

function / cost

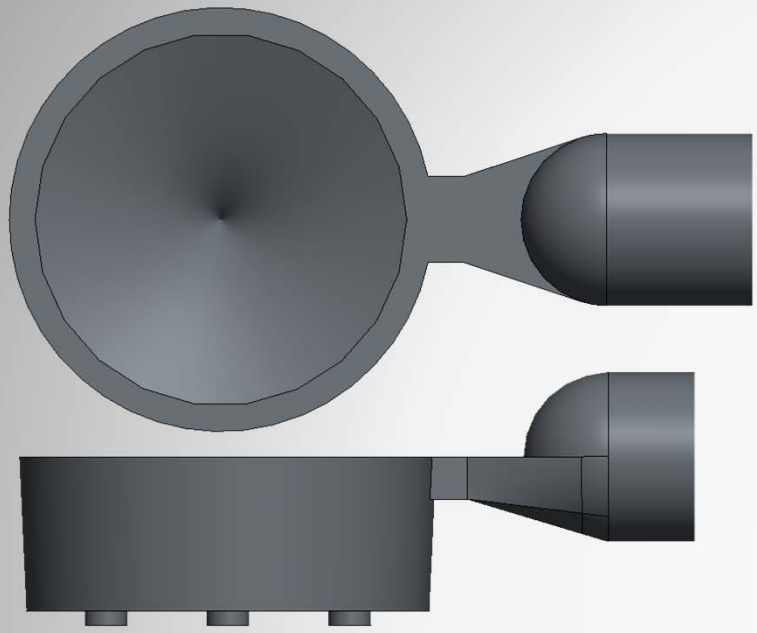
		①	②（Δ10%）	③（Δ20%）
part	g	7.23		
spru		0.69		
runner		5.49	4.94	4.45
shot		13.41	12.86	12.37
production	pcs	24,000,000		
	shot	3,000,000		
annual	ton	40.23	38.58	37.10
			1.65	3.13

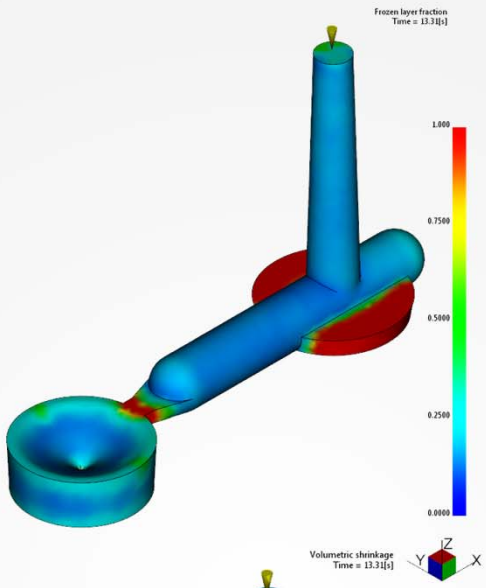


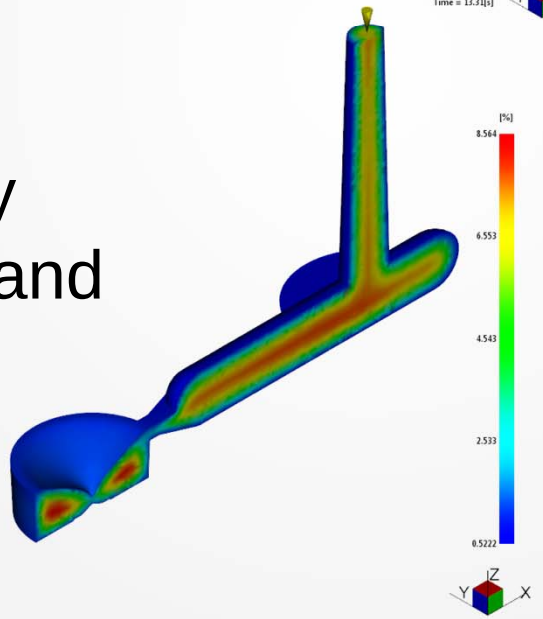


volumetric shrinkage exceeds target

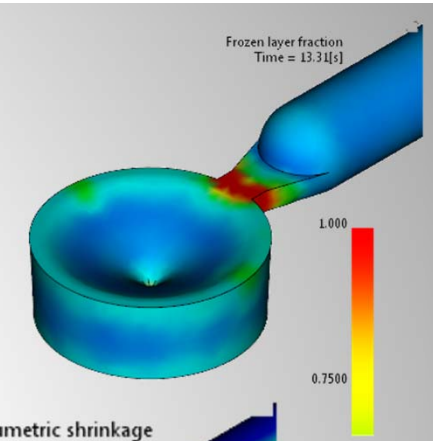
(target from legacy design : 8%)

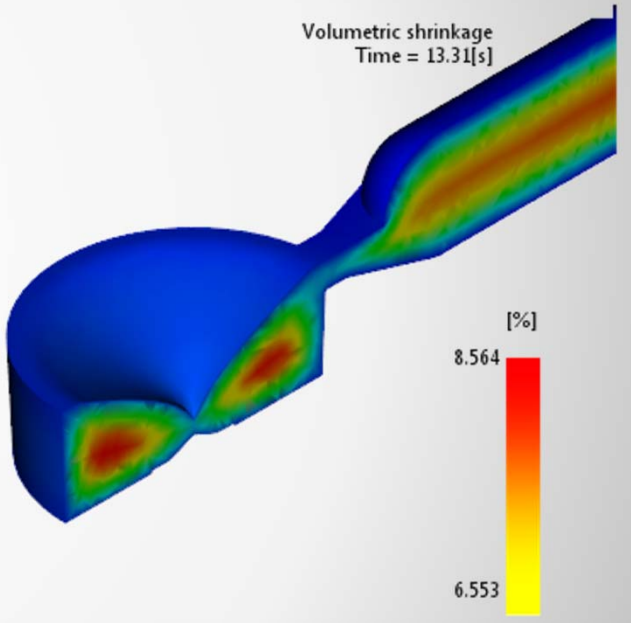




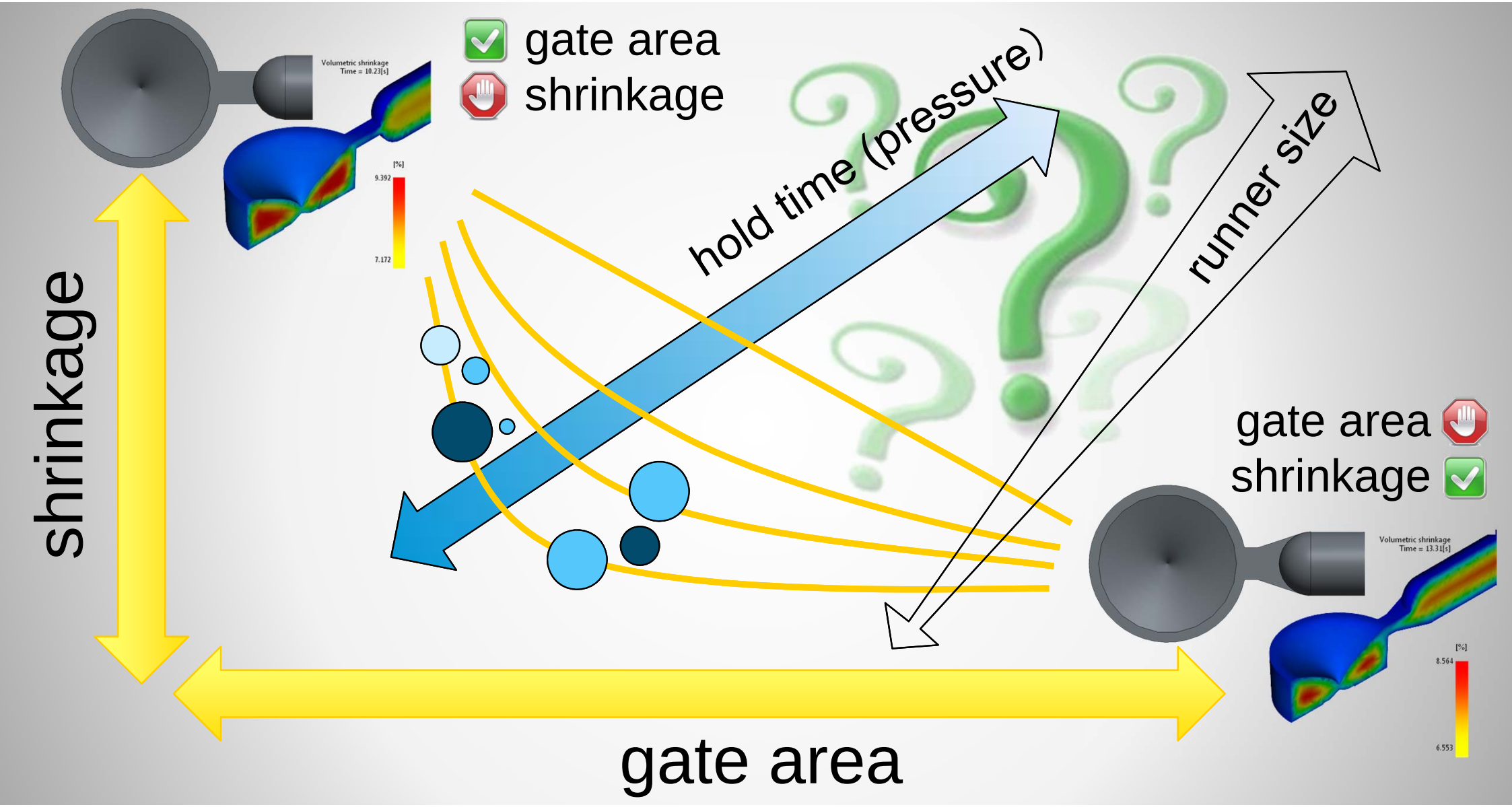


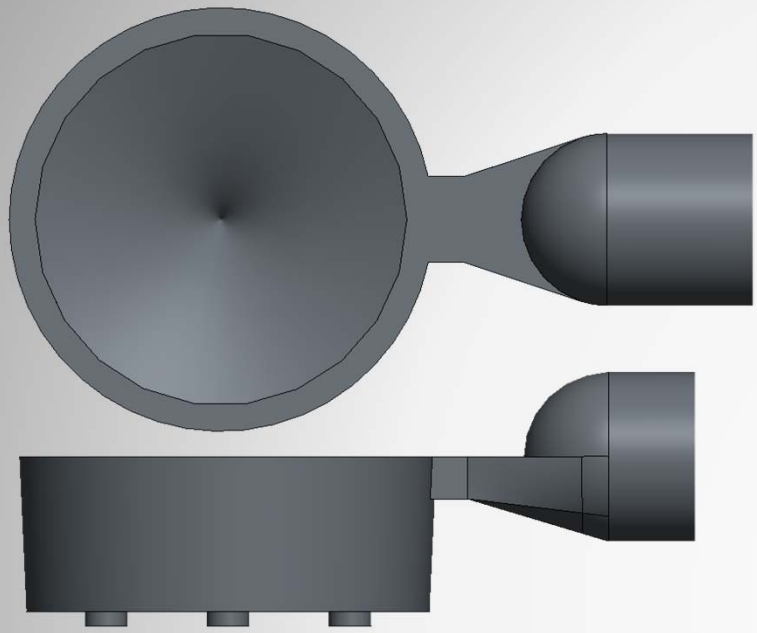
need to simultaneously reduce both gate size and volumetric shrinkage





shrinkage meets target
runner system enlarged


gate area
shrinkage
hold time (pressure)
runner size
shrinkage
gate area
gate area
shrinkage
Volumetric shrinkage
Time = 10.23[s]
[%]
9.392
7.172
Volumetric shrinkage
Time = 13.31[s]
[%]
8.564
6.553



- gate area
- runner volume
- shrinkage

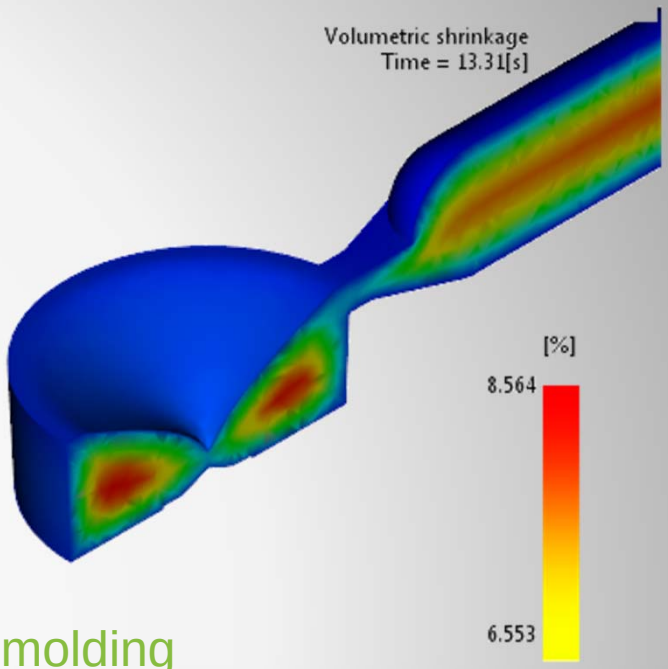
how to simultaneously
reduce these to their minimum ?

inputs affecting shrinkage

- gate & runner size
- hold time
- temperature (material & tool)
- etc

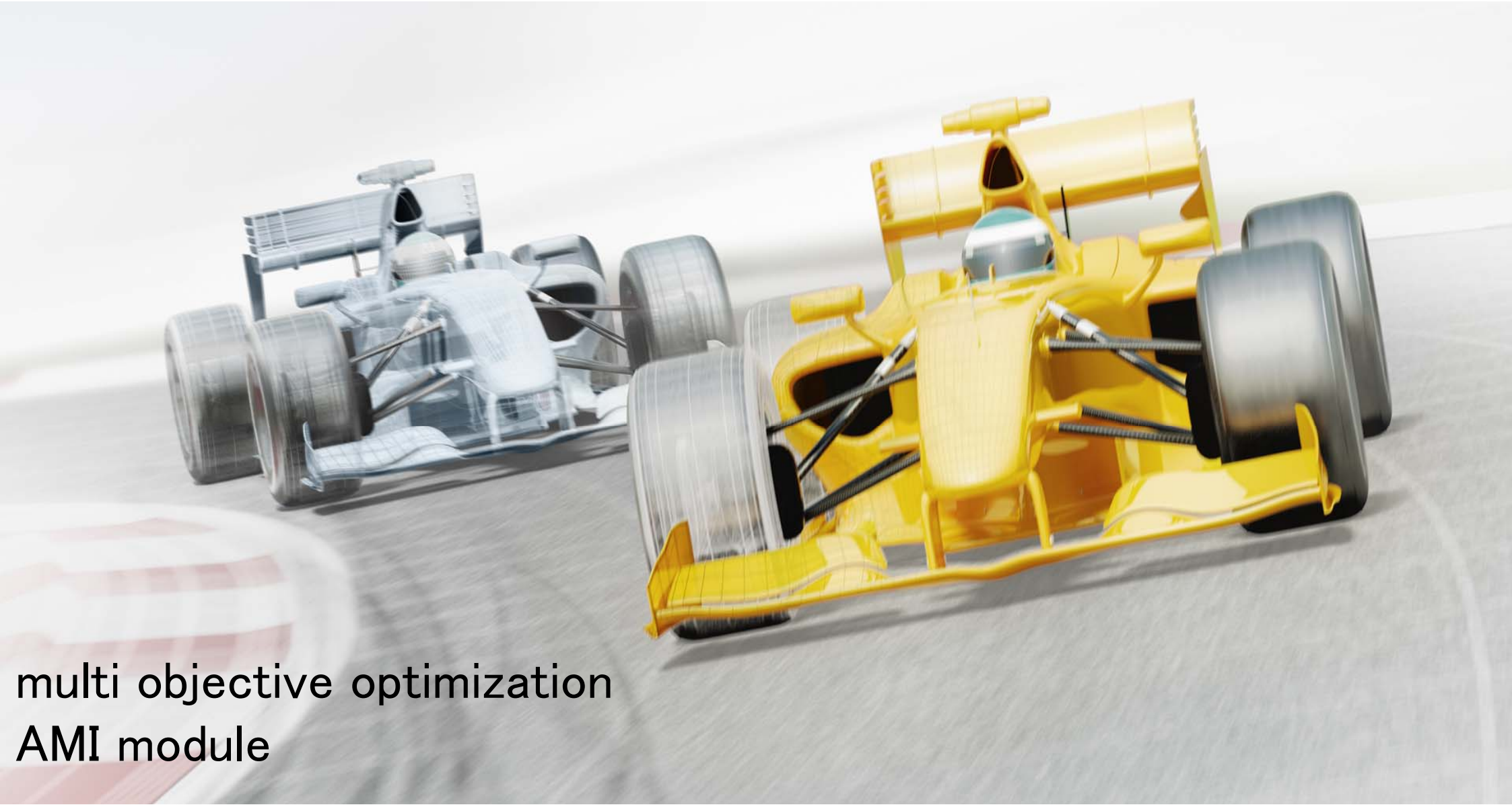
manual optimization difficult

automation（macro）
DOE
etc



geometry / molding

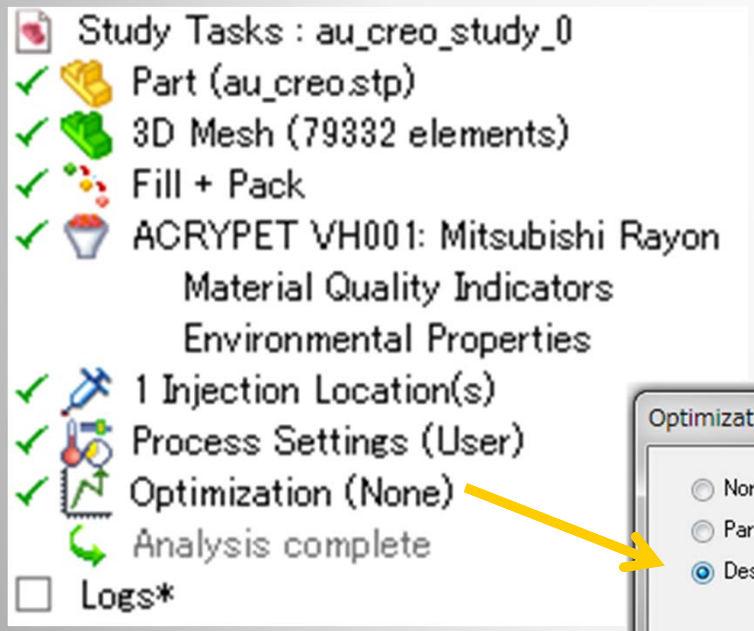
		min	max	step	count
gate width	mm	3	5	0.25	8
gate height	mm	1	2	0.125	8
runner dia	mm	1	4	0.15	20
hold time	s	3	18	0.5	30
mat temp	℃	210	260	10	5
tool temp	℃	50	90	5	8
				total	1,536,000

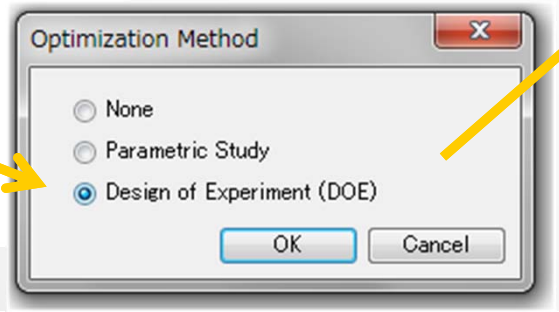


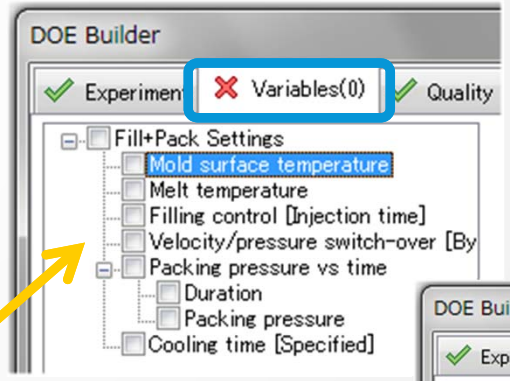
multi objective optimization
AMI module

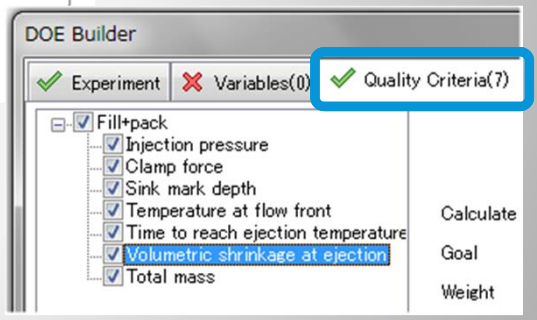
AMI optimization module

- gate & runner size
- hold time
- temperature (material & tool)



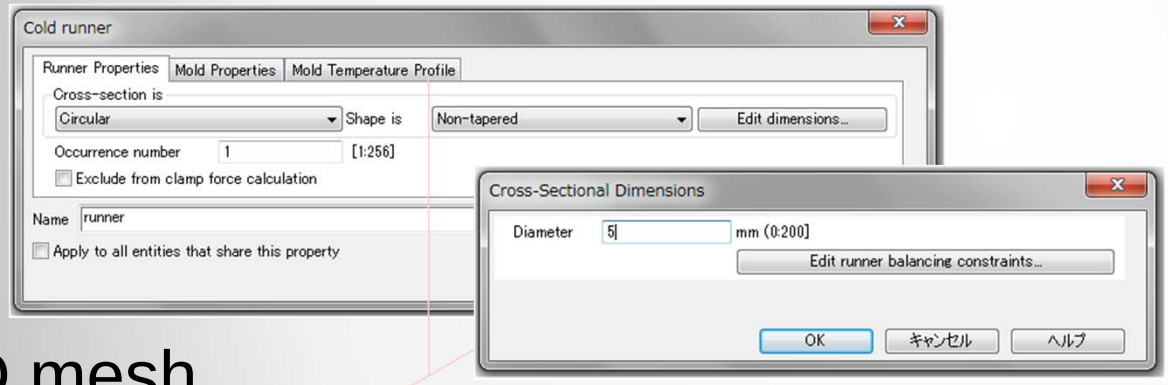


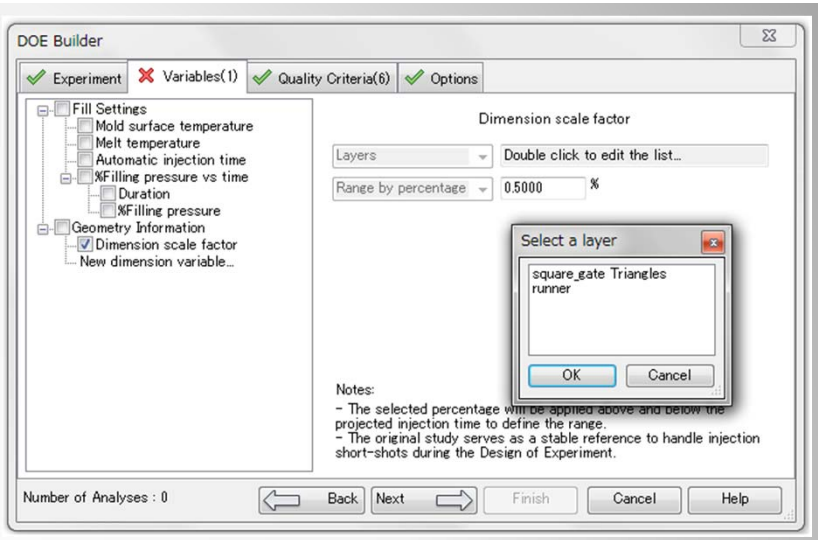




AMI optimization module

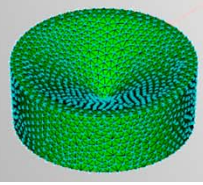
- gate & runner size
- hold time
- temperature (material & tool)



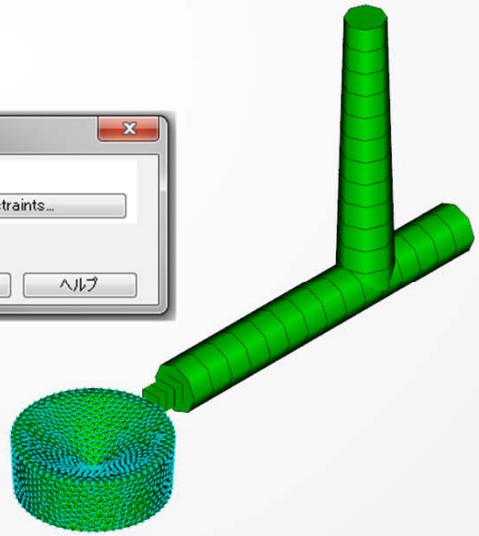


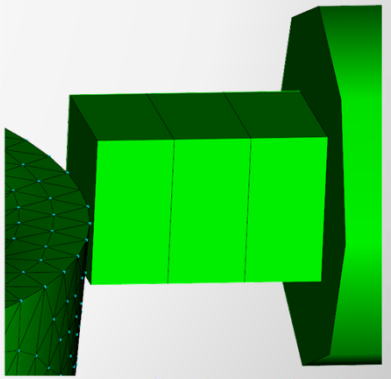
midplane & dual domain

3D mesh



curve





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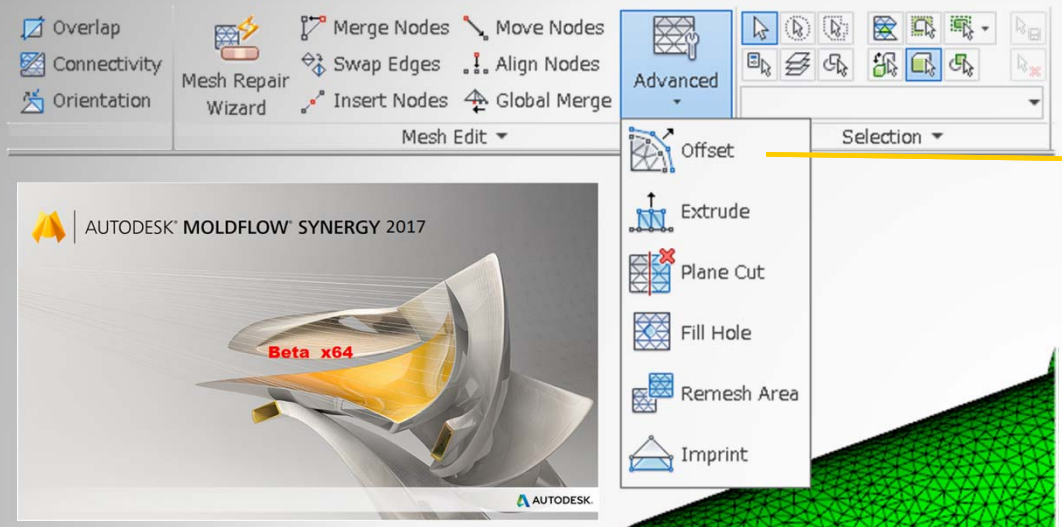
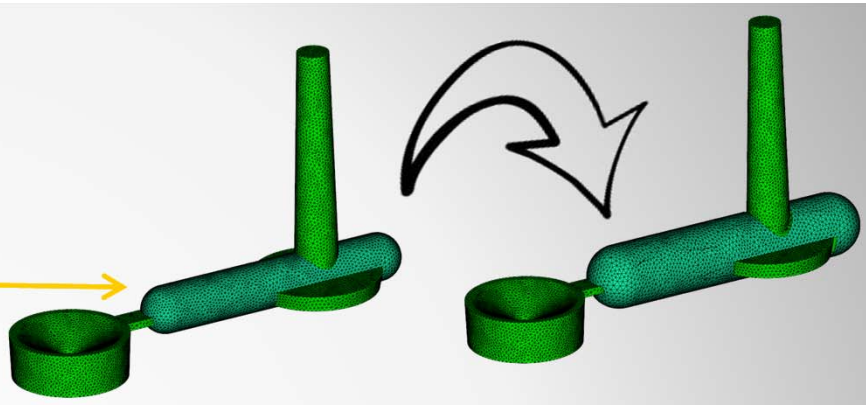
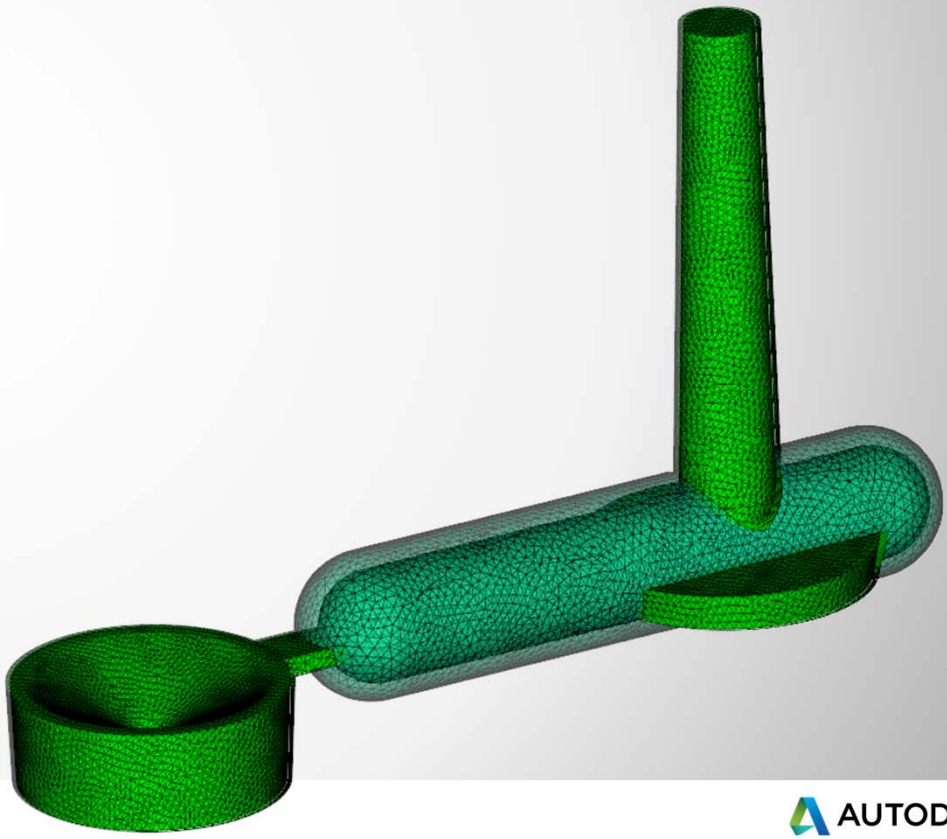
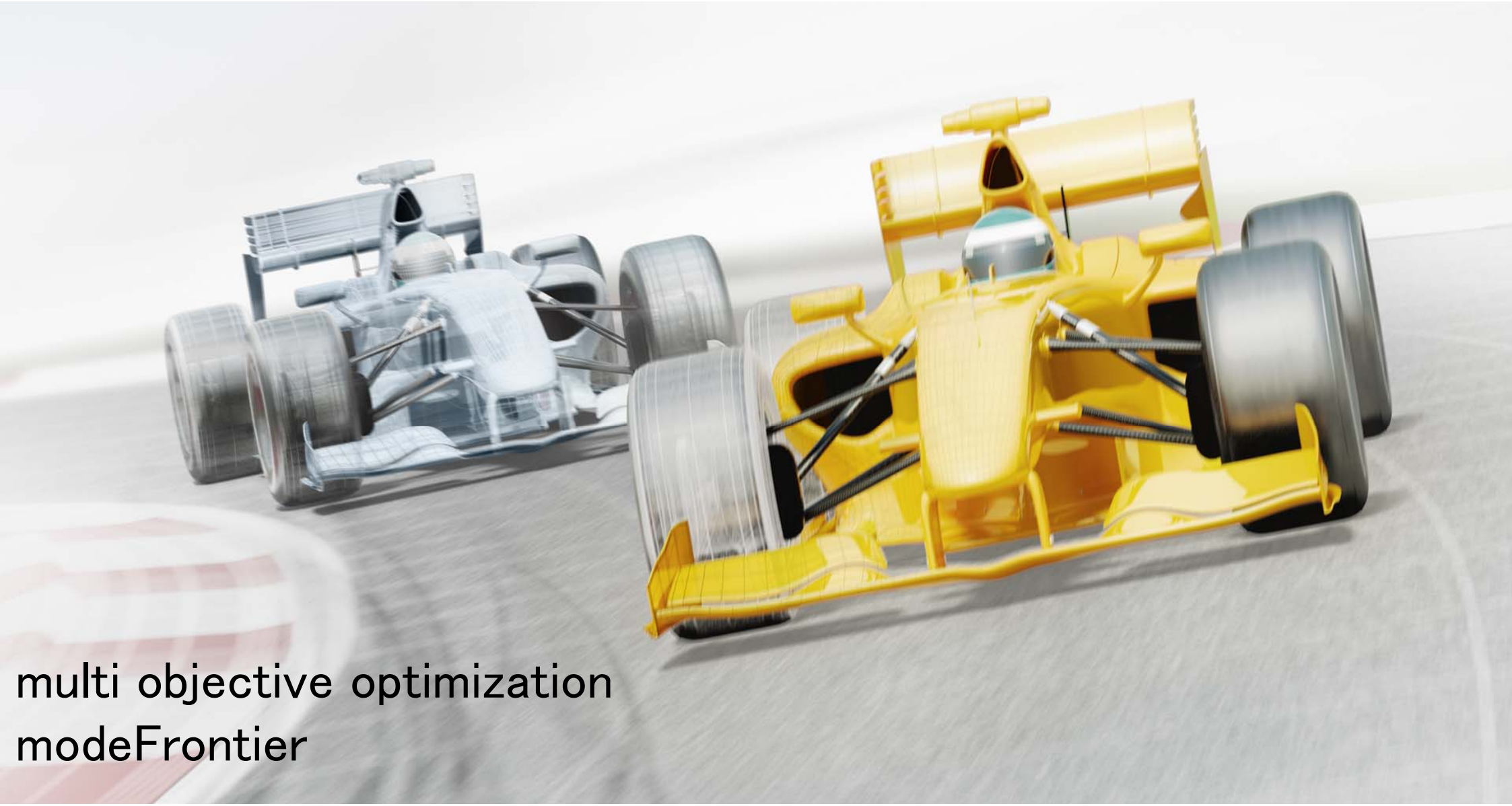
AMI mesh morphing





dual domain mesh

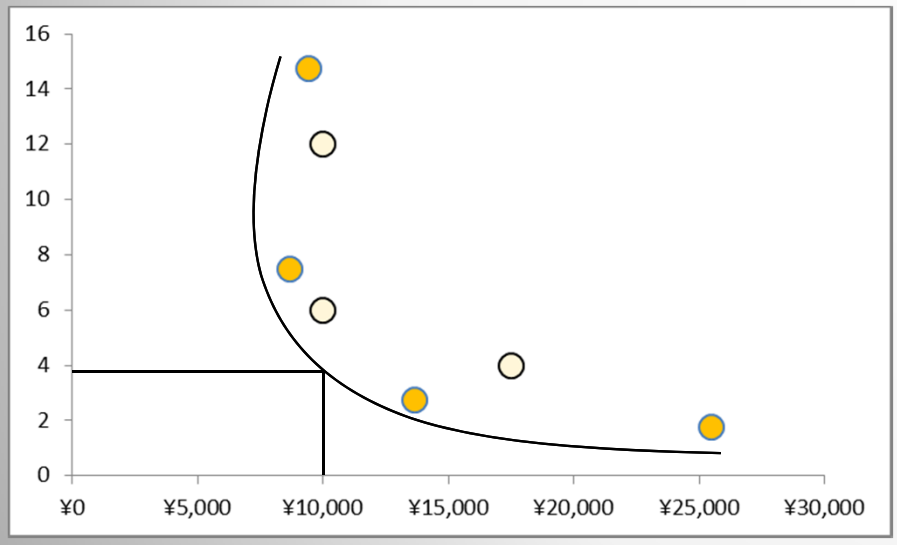


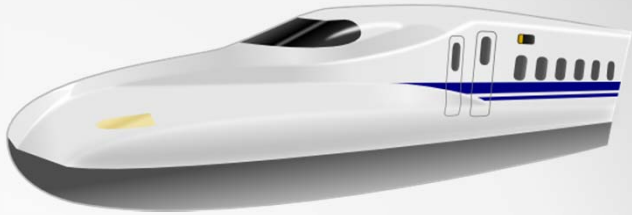


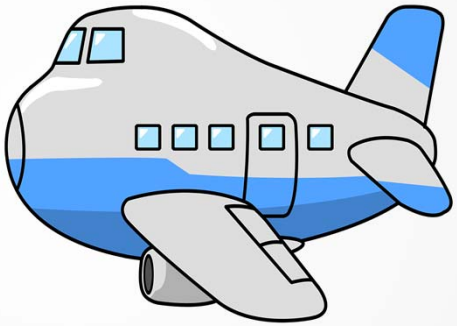
multi objective optimization
modeFrontier

multi objective optimization

	cost	travel time
shinkansen	¥13,620	2.75 h
train	¥9,400	14.75 h
bus	¥8,660	7.5 h
airplane	¥25,490	1.75 h

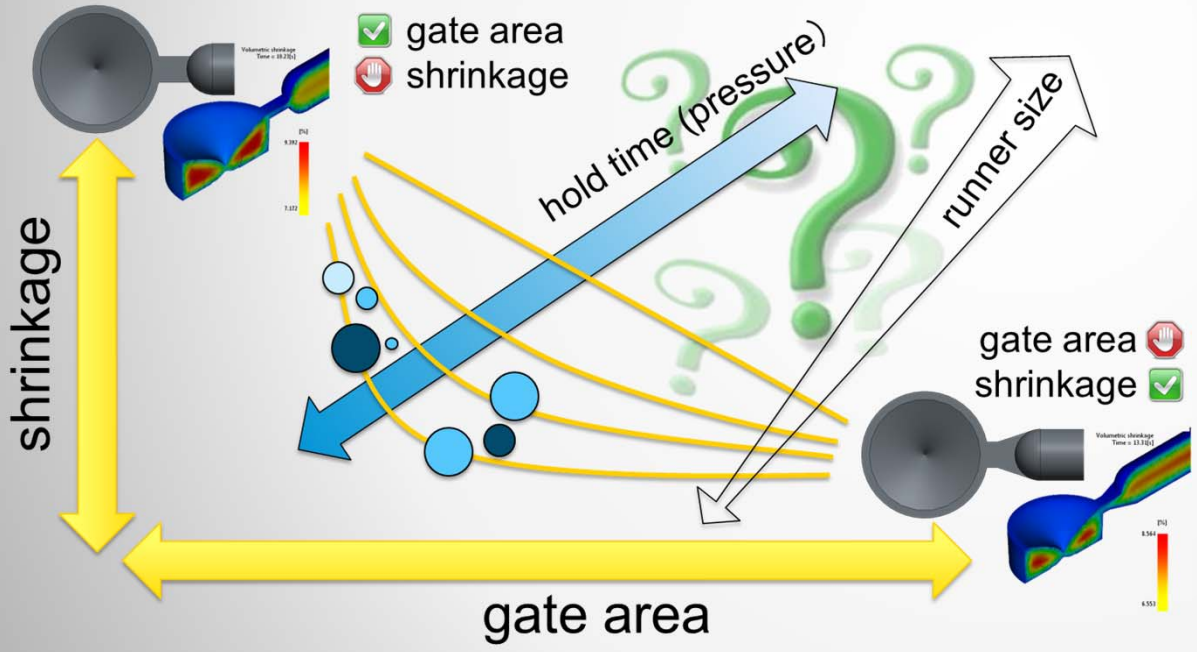


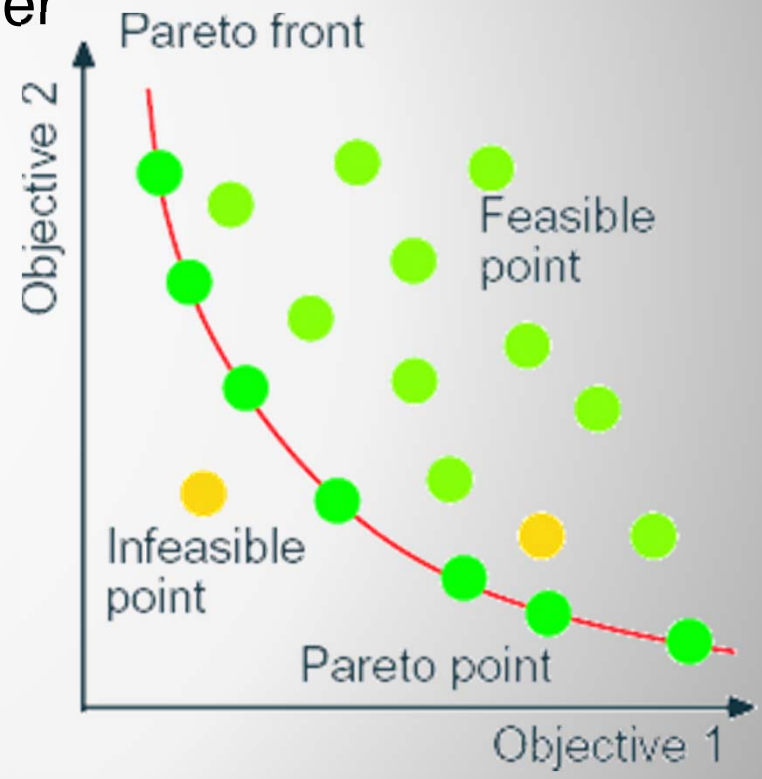




pareto front

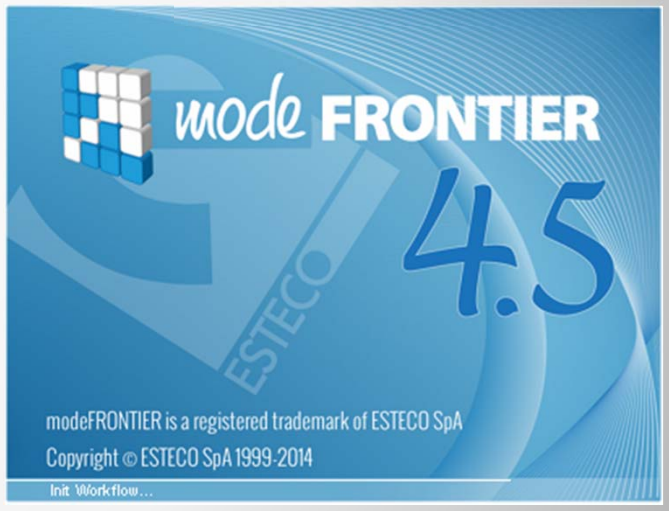
- collection of solutions that meet multiple, sometimes conflicting objectives
- no pareto solution is “better” than any other
- which solution is selected is choice of designer





modeFrontier optimization

- gate & runner size } modified in CREO
- hold time
- temperature (material & tool) } modified in AMI



optimization engine : modeFrontier

Esteco

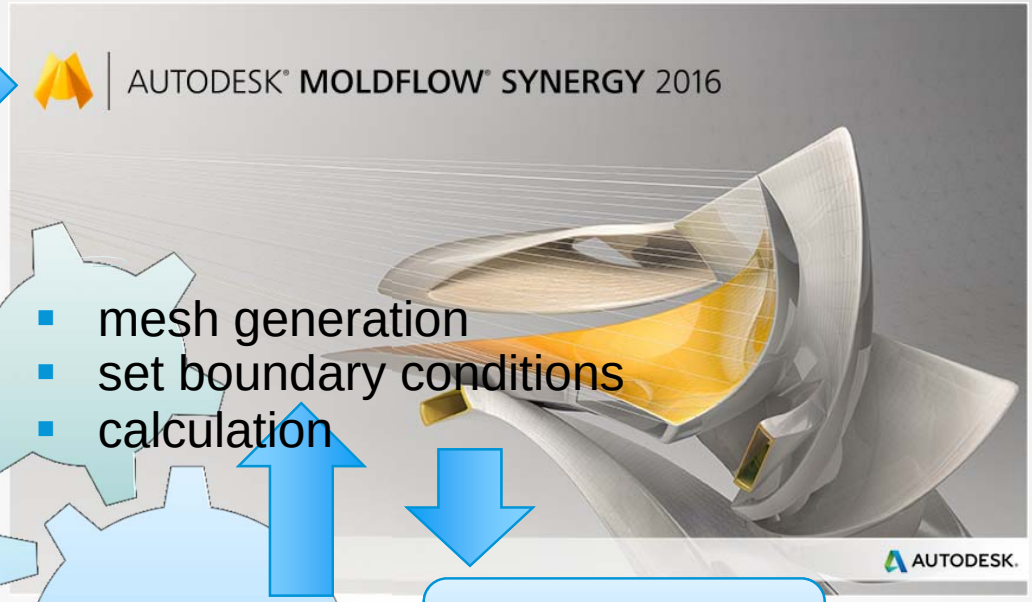
modeFRONTIER
the multi-objective optimization and design environment

In the late 1990's, three Italian Engineers, Carlo Poloni, Luka Onesti and Enrico Nobile, created a spin off company turning the knowledge acquired during a European Union funded project on design optimization into a successful commercial product.

At the end of the project, EnginSoft SpA was appointed as a sub-contractor to evaluate the commercial potential of a software called "Frontier". Thanks to the positive results, EnginSoft and the three researchers decided to create a new company acquiring the IP of the project.
In 1999 ESTECO was founded offering a multi-objective optimization platform called modeFRONTIER.

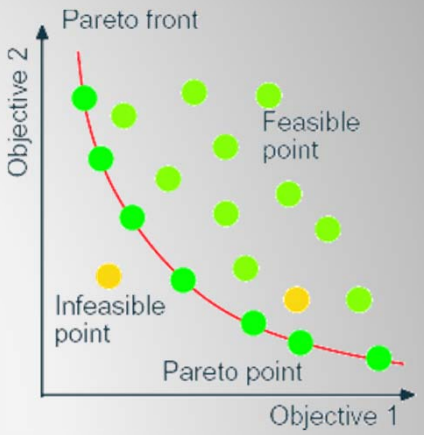
input

- gate size
- runner size
- hold time
- temperature
- etc



- mesh generation
- set boundary conditions
- calculation

creo™
A PTC Product



output

- shrinkage
- etc

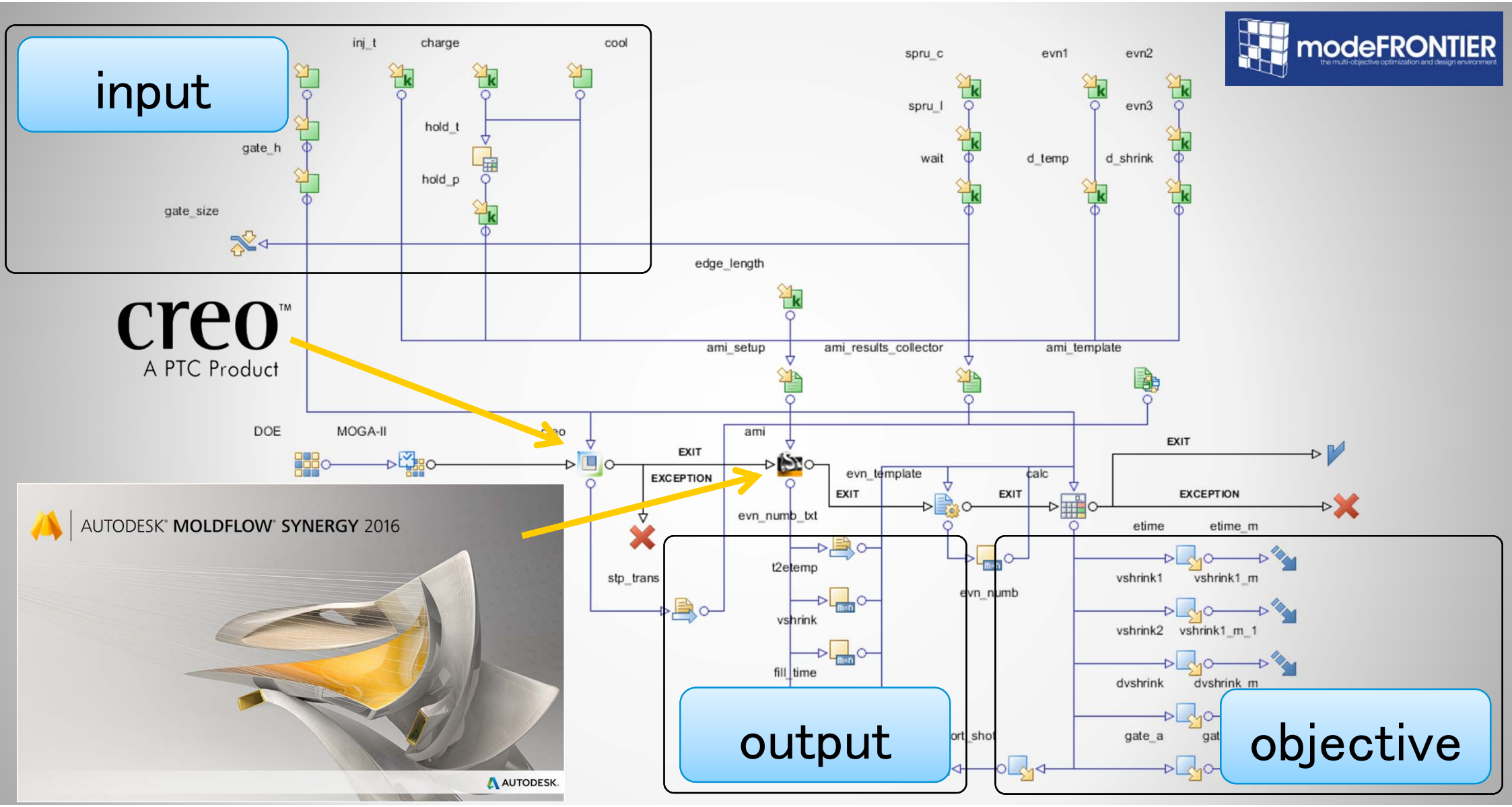
objective

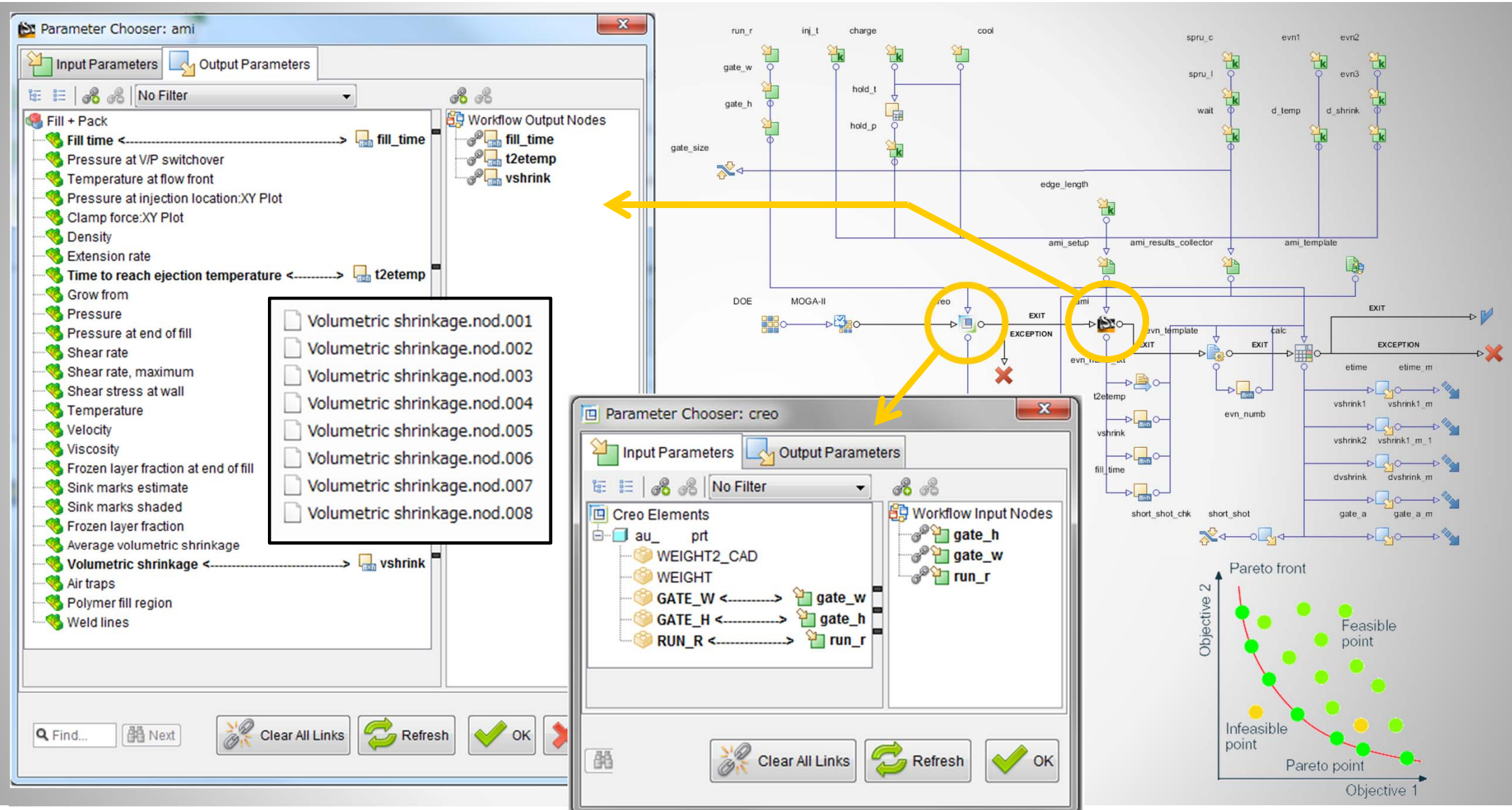
- gate area : min
- runner size : min
- hold time : min
- shrinkage : min
- etc

modeFRONTIER
the multi-objective optimization and design environment

evaluate output vs objective

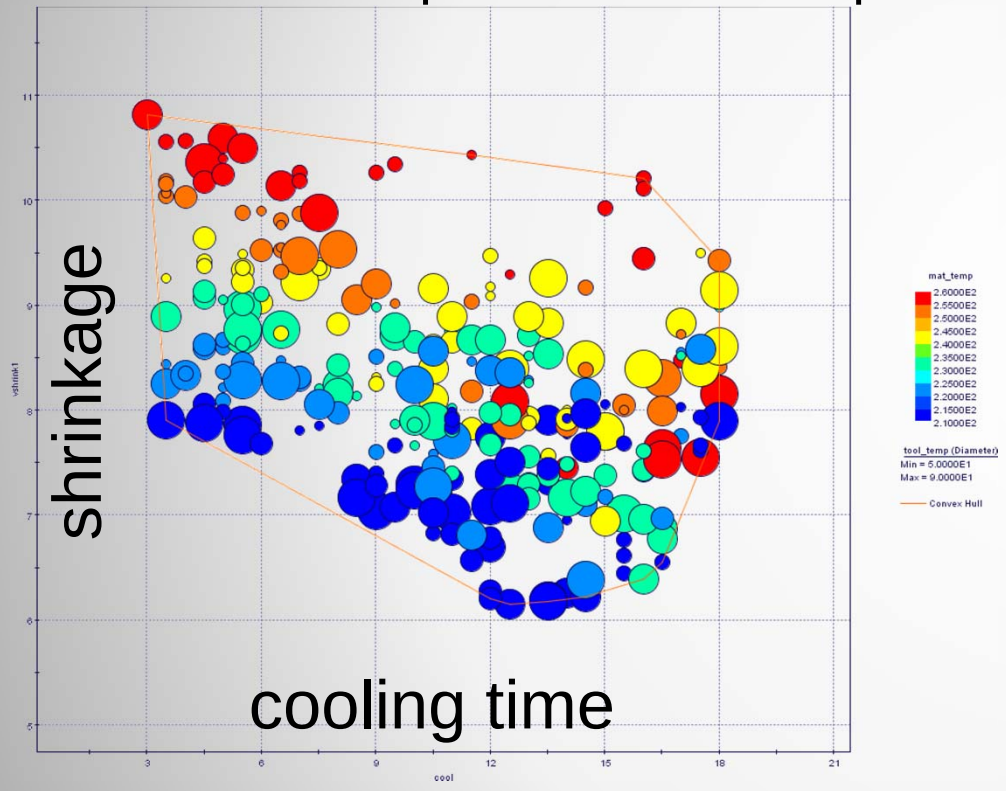
modify inputs driving output to objectives


input
inj_t
charge
cool
gate_h
hold_t
hold_p
gate_size
spru_c
evn1
evn2
spru_l
evn3
wait
d_temp
d_shrink
edge_length
creo™
A PTC Product
ami_setup
ami_results_collector
ami_template
DOE
MOGA-II
ami
EXIT
EXCEPTION
evn_template
calc
evn_numb_txt
stp_trans
t2etemp
vshrink
fill_time
evn_numb
etime
etime_m
vshrink1
vshrink1_m
vshrink2
vshrink1_m_1
dvshrink
dvshrink_m
gate_a
output
objective
AUTODESK® MOLDFLOW® SYNERGY 2016
AUTODESK.
modeFRONTIER
the multi-objective optimization and design environment

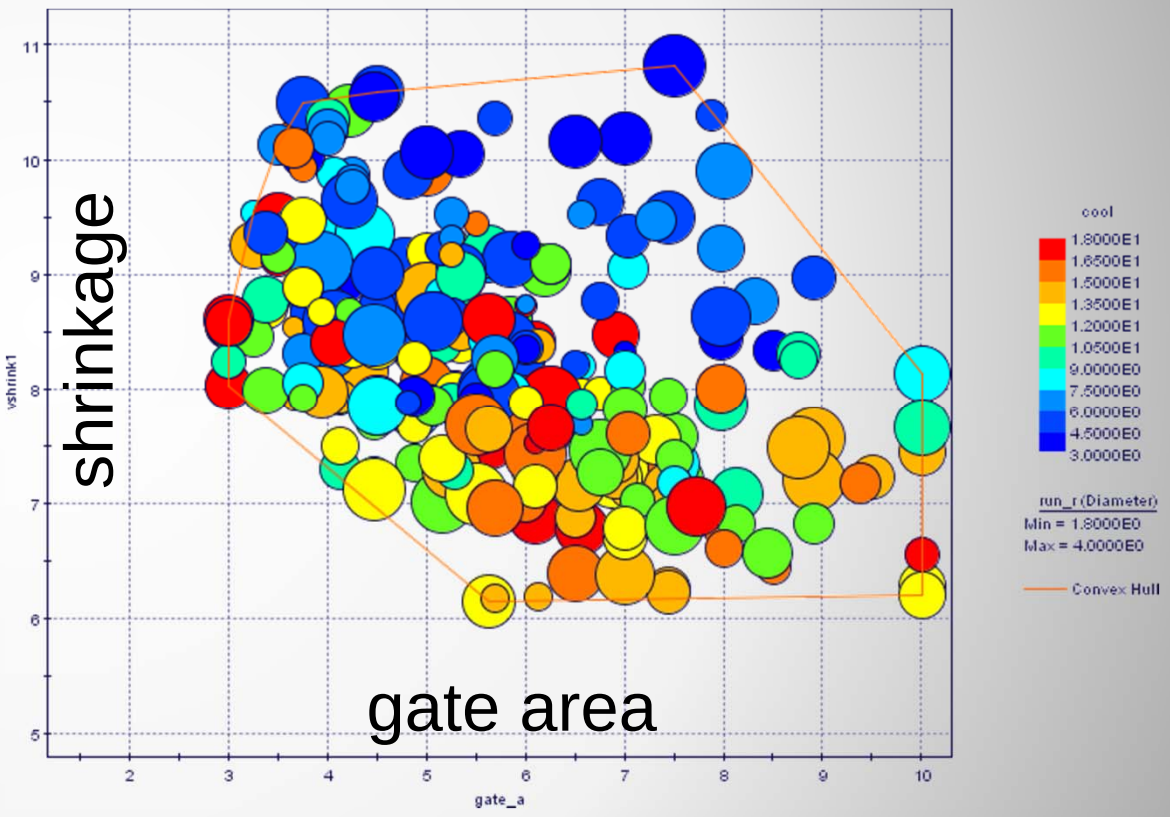

Parameter Chooser: ami
Input Parameters
Output Parameters
No Filter
Fill + Pack
Fill time <----------> fill_time
Pressure at V/P switchover
Temperature at flow front
Pressure at injection location:XY Plot
Clamp force:XY Plot
Density
Extension rate
Time to reach ejection temperature <----------> t2etemp
Grow from
Pressure
Pressure at end of fill
Shear rate
Shear rate, maximum
Shear stress at wall
Temperature
Velocity
Viscosity
Frozen layer fraction at end of fill
Sink marks estimate
Sink marks shaded
Frozen layer fraction
Average volumetric shrinkage
Volumetric shrinkage <----------> vshrink
Air traps
Polymer fill region
Weld lines
Workflow Output Nodes
fill_time
t2etemp
vshrink
Volumetric shrinkage.nod.001
Volumetric shrinkage.nod.002
Volumetric shrinkage.nod.003
Volumetric shrinkage.nod.004
Volumetric shrinkage.nod.005
Volumetric shrinkage.nod.006
Volumetric shrinkage.nod.007
Volumetric shrinkage.nod.008
Find...
Next
Clear All Links
Refresh
OK
run_r
inj_t
charge
cool
gate_w
gate_h
hold_t
hold_p
gate_size
edge_length
spru_c
evn1
evn2
spru_l
evn3
wait
d_temp
d_shrink
ami_setup
ami_results_collector
ami_template
DOE
MOGA-II
creo
ami
EXIT
EXCEPTION
evn_template
calc
t2etemp
vshrink
fill_time
evn_numb
etime
etime_m
vshrink1
vshrink1_m
vshrink2
vshrink1_m_1
dvshrink
dvshrink_m
short_shot_chk
short_shot
gate_a
gate_a_m
Parameter Chooser: creo
Input Parameters
Output Parameters
No Filter
Creo Elements
au_ prt
WEIGHT2_CAD
WEIGHT
GATE_W <----------> gate_w
GATE_H <----------> gate_h
RUN_R <----------> run_r
Workflow Input Nodes
gate_h
gate_w
run_r
Clear All Links
Refresh
OK
Pareto front
Objective 2
Feasible point
Infeasible point
Pareto point
Objective 1

results

color：mat temp / size：tool temp

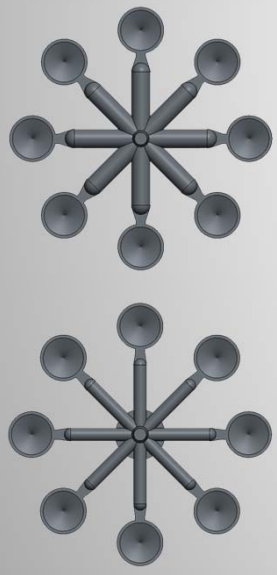


color：hold time / size：runner size



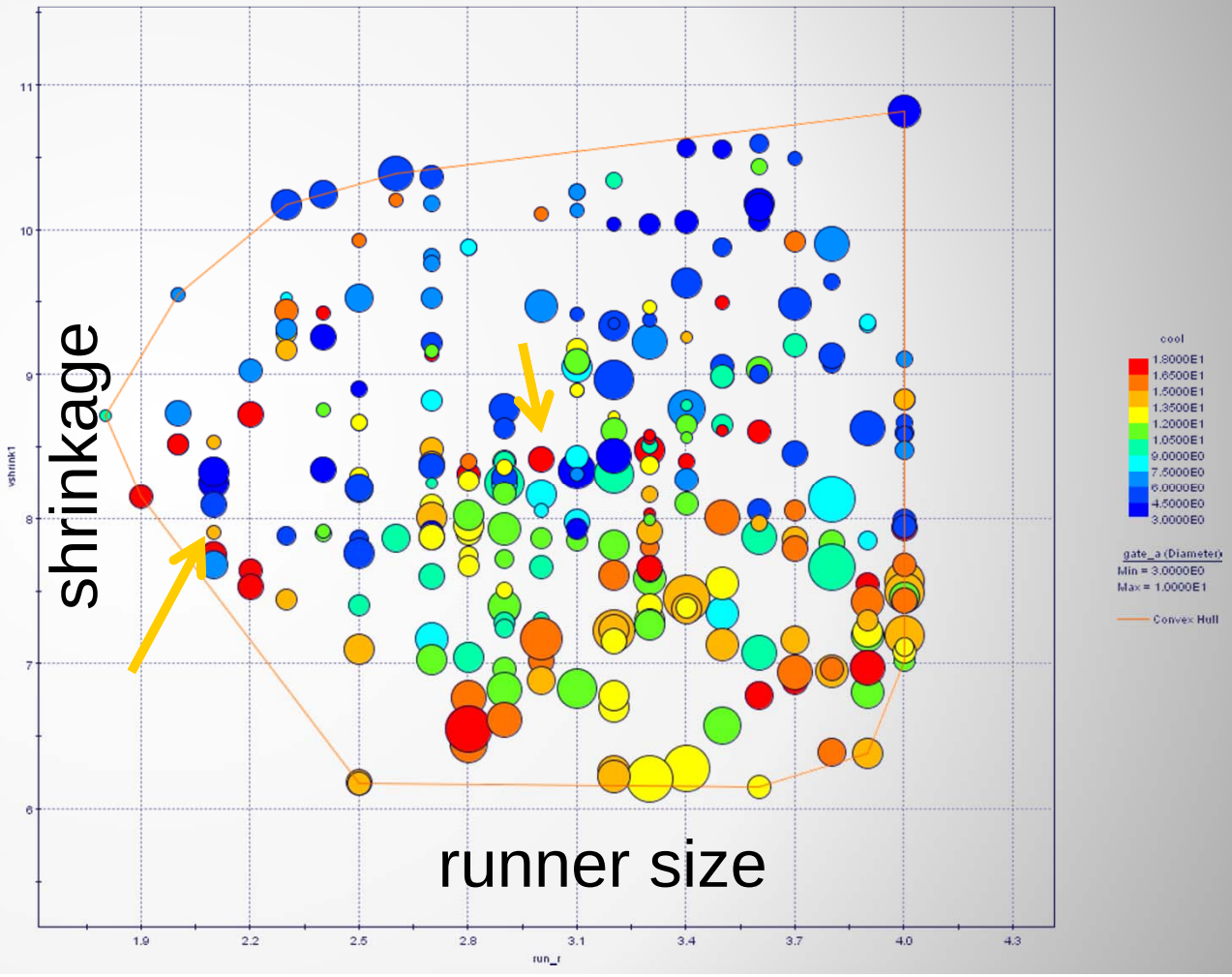
results

		min	max	legacy	optimized
gate width	mm	3	5	3	3.25
gate height	mm	1.5	2	2	1.125
gate area	mm^2			6	3.66
runner dia	mm	1	4	3	2.1
hold time	s	3	18	18	13.5
mat temp	℃	210	260	250	210
tool temp	℃	50	90	60	80
shrinkage	%			8.42	7.91

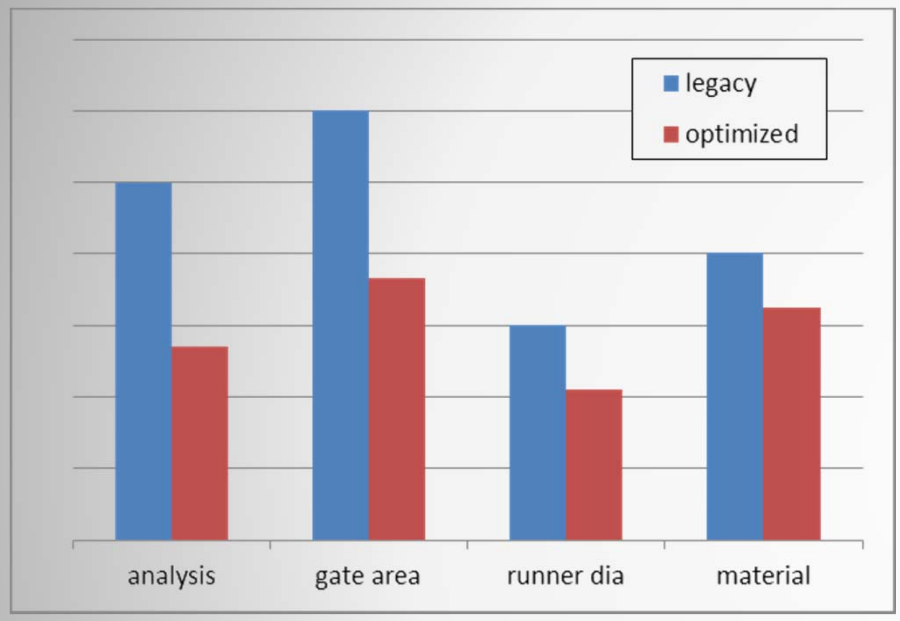


		legacy	optimized
part	g	7.23	
spru	g	0.69	
runner	g	5.49	2.92
shot	g	13.41	10.84
production	pcs	24,000,000	
	shot	3,000,000	
annual	ton	40.23	32.52
	ton		7.71

color：cool time / size：gate area



modeFrontier optimization



		legacy	optimized	Δ
analysis	day	5	2.7	46%
gate area	mm²	6	3.66	39%
runner dia	mm	3	2.1	30%
material	10t	4.023	3.25	19%

		min	max	step	count
gate width	mm	3	5	0.25	8
gate height	mm	1	2	0.125	8
runner dia	mm	1	4	0.15	20
hold time	s	3	18	0.5	30
mat temp	℃	210	260	10	5
tool temp	℃	50	90	5	8

							modeFrontier
				total	1,536,000		336

Total Designs	336
Error Designs	53
Unfeasible Desi...	0
Virtual Designs	0

calc time : ~10min / run (total 61.8h)

- CAD generation
- mesh generation
- set boundary conditions
- calculations
- result extraction and processing

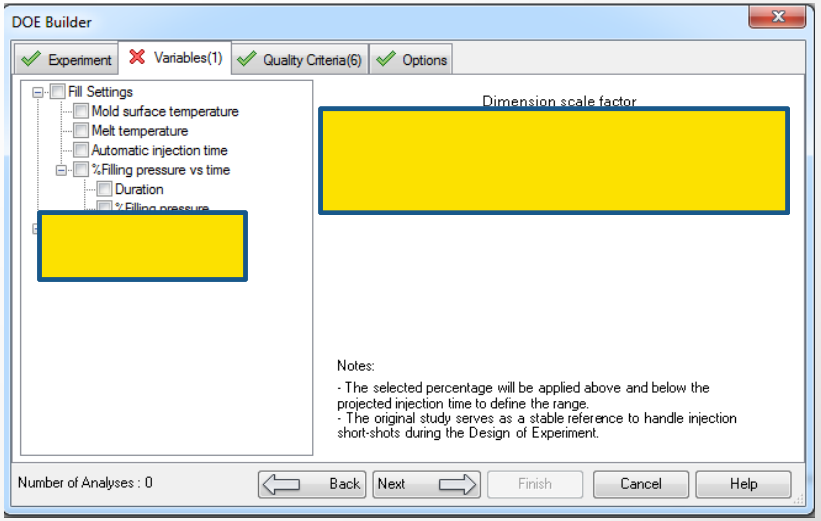
Special thanks to
AUTODESK Enterprise Support & IDAJ

Latest developments related Design Optimization within Autodesk Moldflow

Why can this not be fully done within Moldflow yet?

Strictly speaking, there are already a few things:

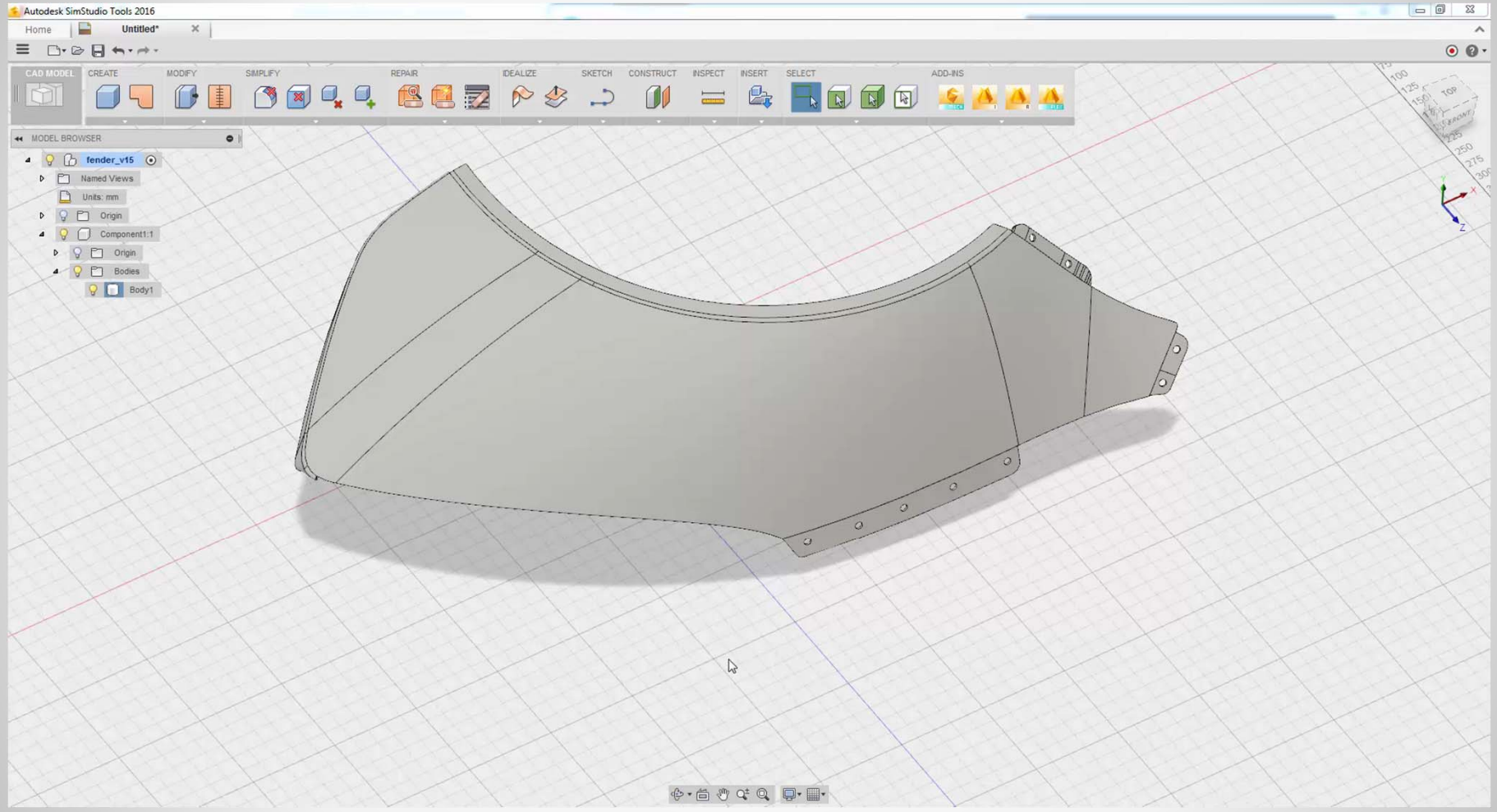
- Runner balancing
- You can already make thickness changes within the DOE builder for Midplane and Domain Models.



Ok, but seriously, why is this so hard?

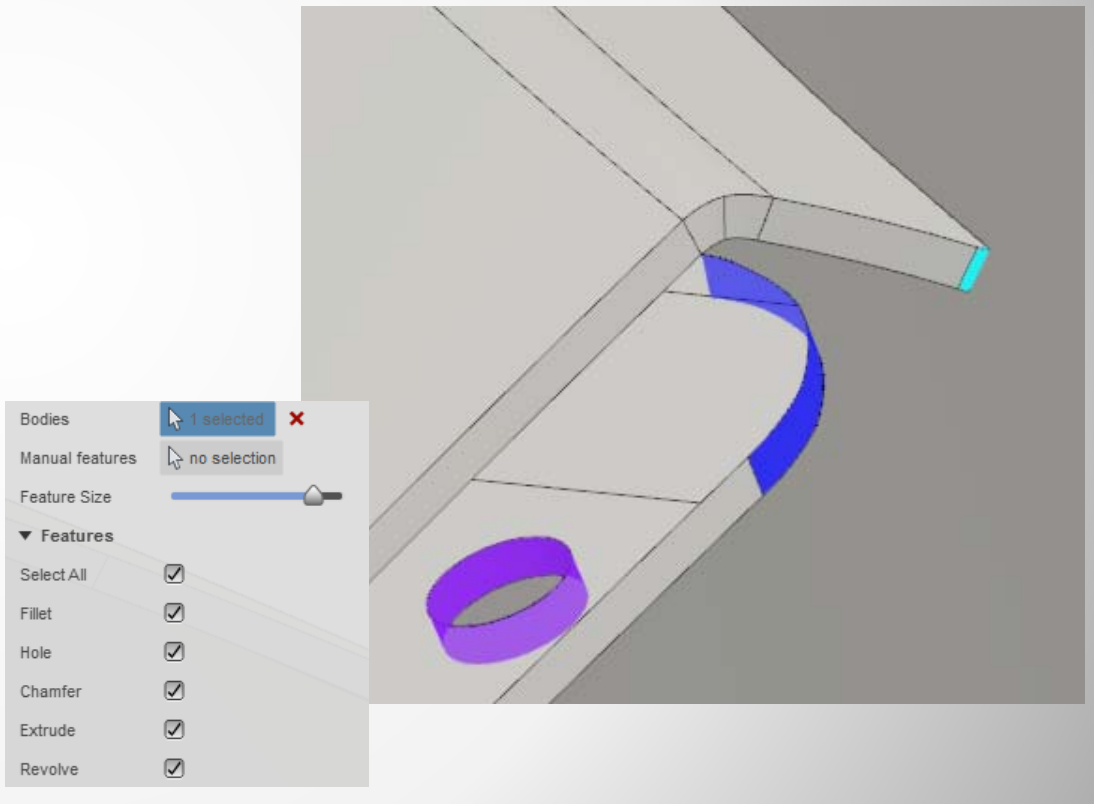
- Models imported into Moldflow as ‘dumb geometry’
  - Models coming into Simulation products are from many CAD systems and in many formats.
  - Parametric data is no longer available and doesn’t fit free forms
  - Feature recognition technology is not robust
  - Edits are hard and not always successful

Example?


Autodesk SimStudio Tools 2016
Home
Untitled*
CAD MODEL
CREATE
MODIFY
SIMPLIFY
REPAIR
IDEALIZE
SKETCH
CONSTRUCT
INSPECT
INSERT
SELECT
ADD-INS
MODEL BROWSER
fender_v15
Named Views
Units: mm
Origin
Component1:1
Origin
Bodies
Body1

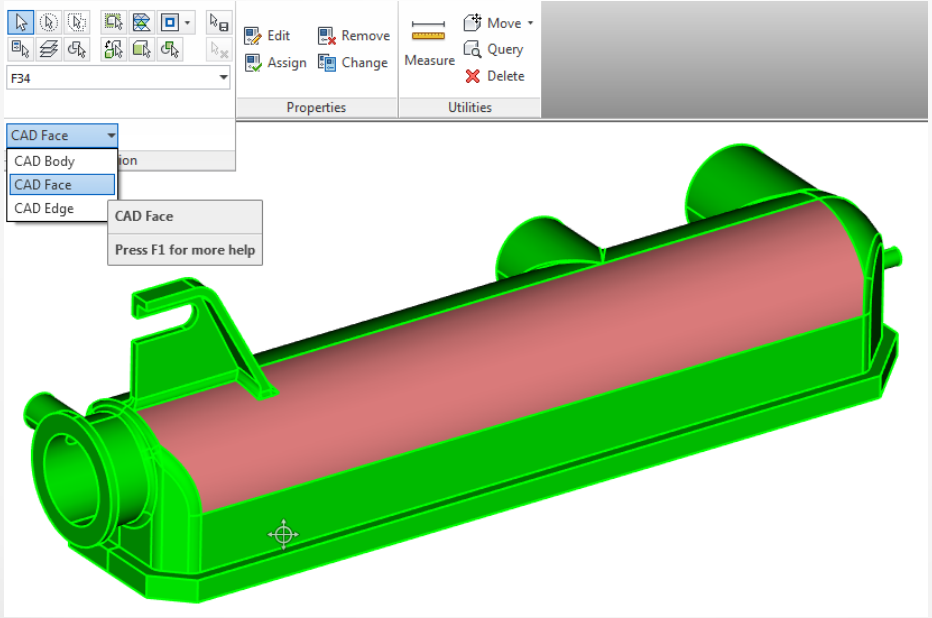
Example?

- Limited success in finding features or parameters on this STEP model. Hard for:
  - Non-planar faces and blends



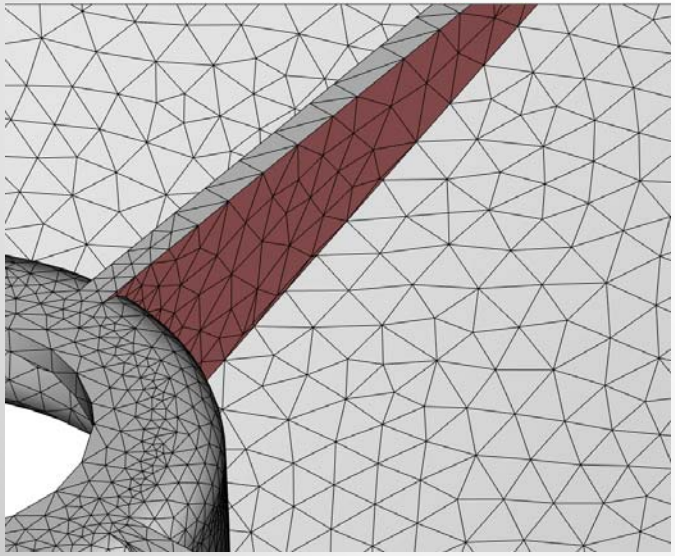
Three New Developments

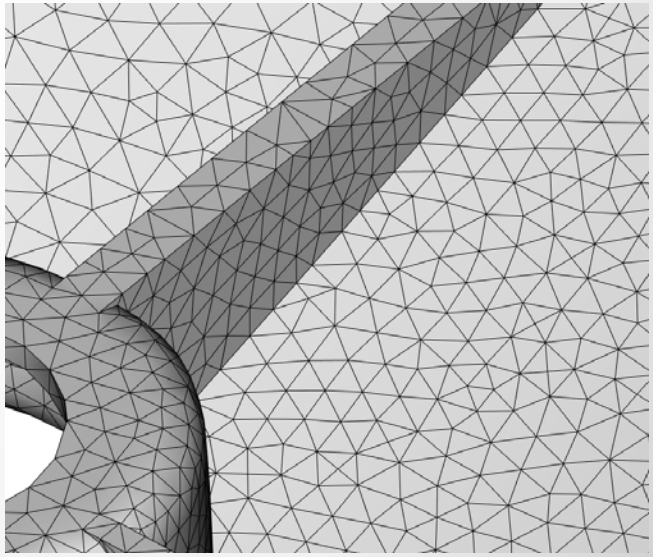
1. Full integration of the ASM kernel in Moldflow (2017 Beta)
   - Actively developed Standard Autodesk component
   - Face, edge and body selection in 2017
   - Many other possibilities down the line



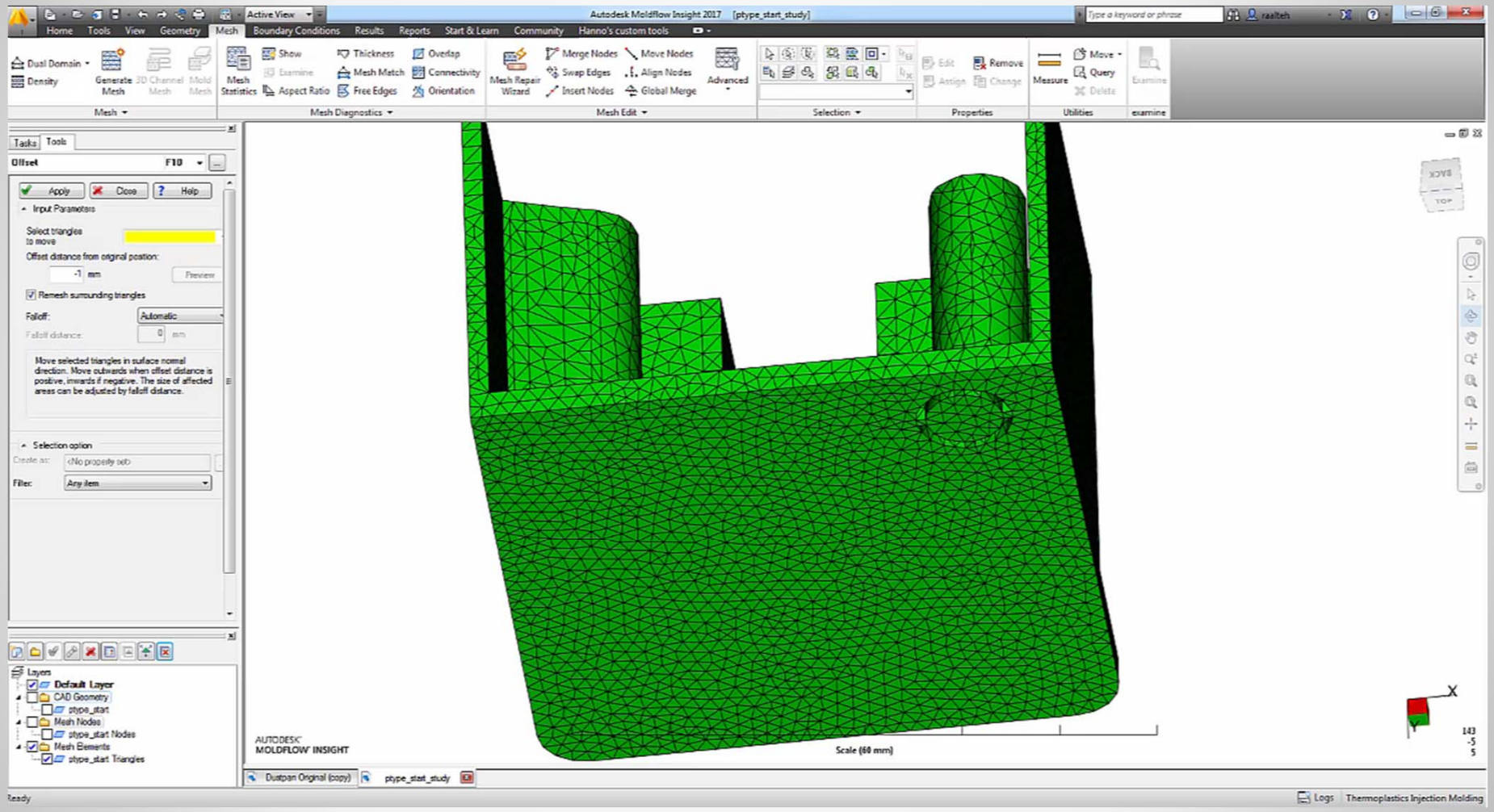
Three new developments

2. Advanced Surface Mesh based operations (in 2017 Beta):
   - Move surface meshes in normal directions (MeshMixer/Memento Tech)
   - Automatically re-meshes and resolve intersection problems in neighboring surfaces





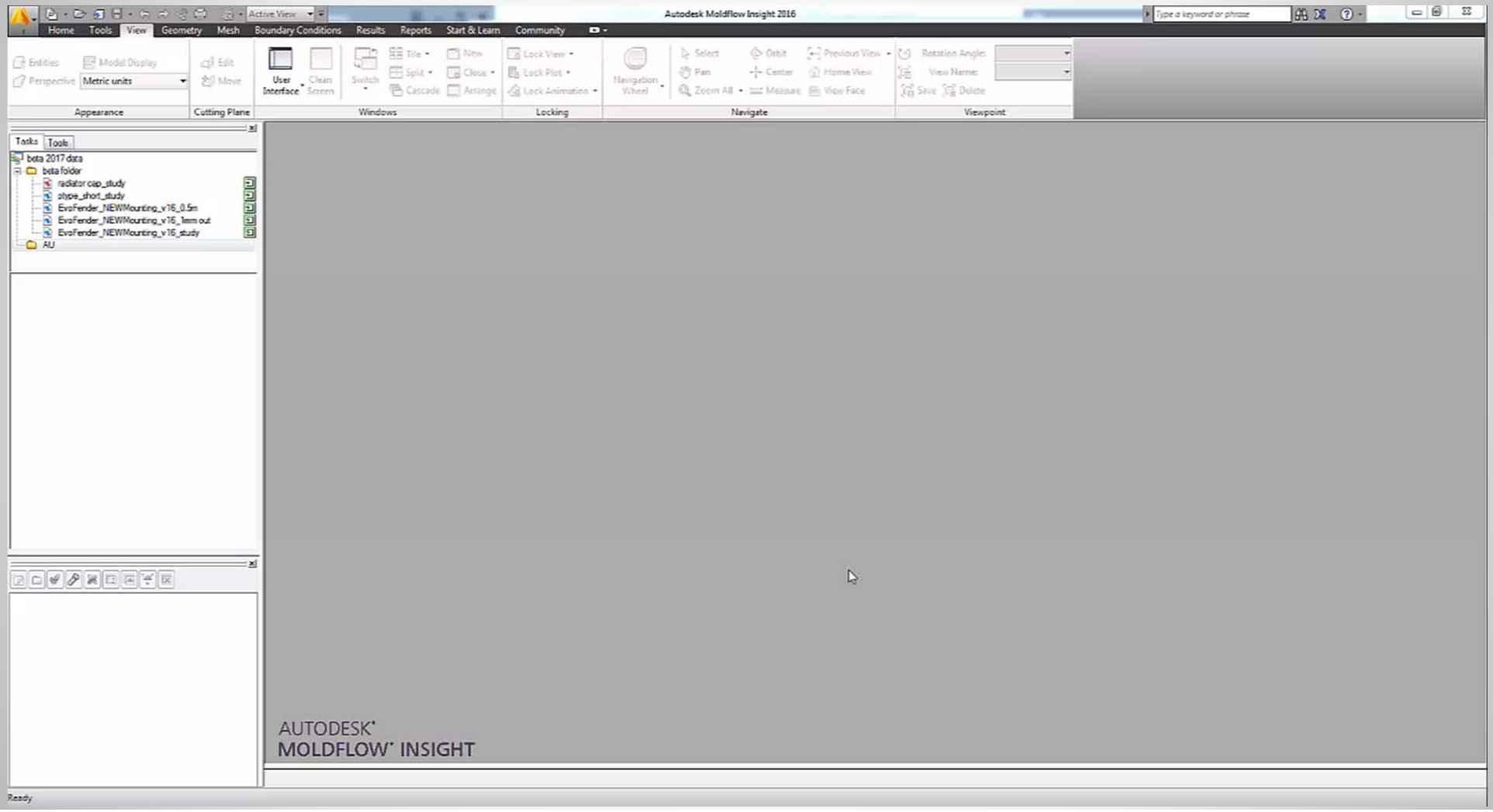
Advanced Surface Mesh based operations



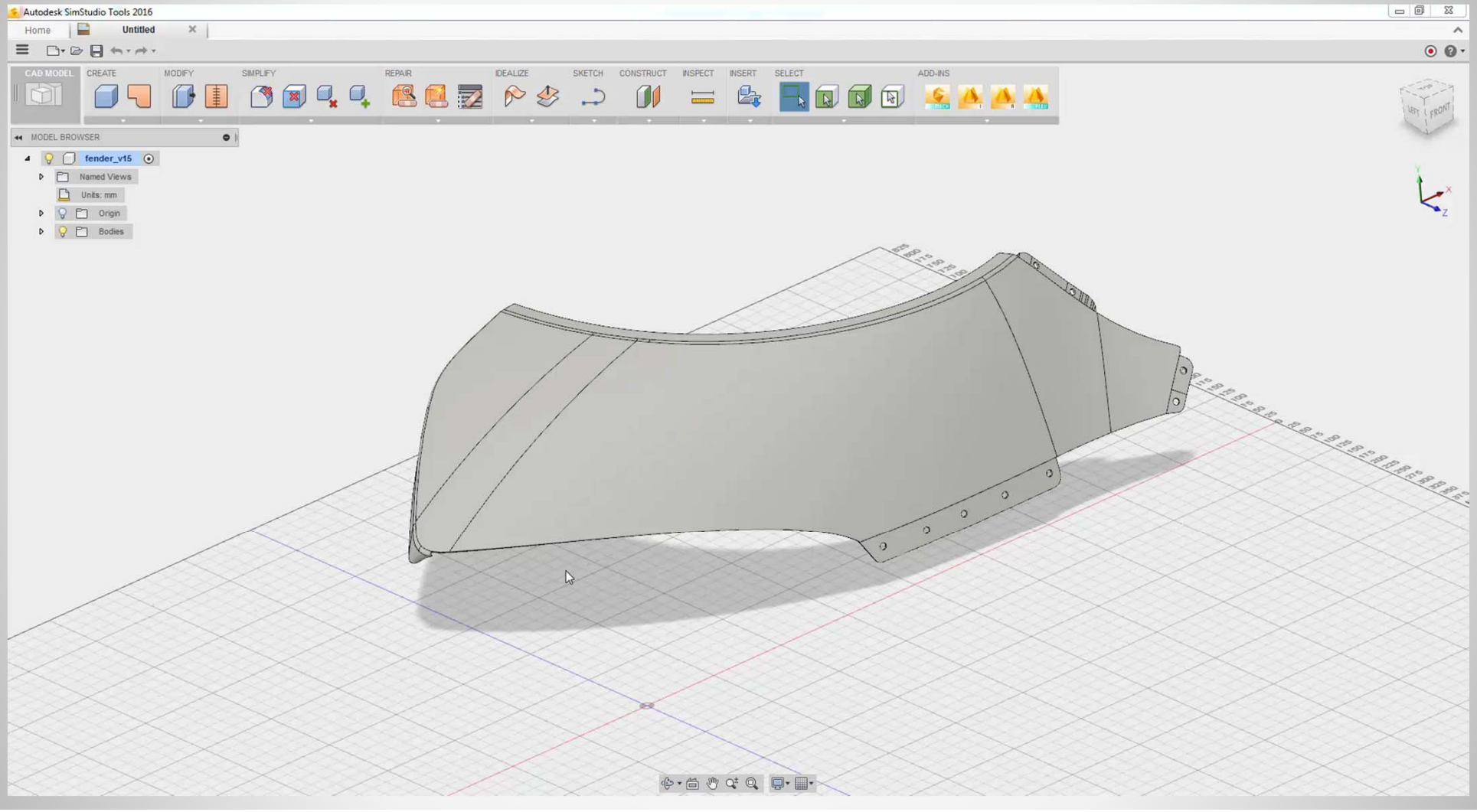
Three new developments

3. Morphing CAD geometry (not in 2017 Beta)
   - Using GoSculpter Technology
   - “Always possible” even for complex and free form geometry
   - Smoothness is guaranteed

Morphing CAD geometry



Same Modification in Sim Studio Tools



Much work to be done

Very exciting work, but much work to be done:

- Need to develop deformation tools for the most common morphing scenarios
- Allow edge geometry to be free or fixed
- Combined operations
- Requires a Meshing in DOE and Parametric Study
- Connect to DOE
- Expose all components to 3rd party optimization tools
- Speed-up
- Export of optimized CAD model

Be heard! Provide AU session feedback.

- Via the Survey Stations, email or mobile device.
- AU 2016 passes awarded daily!
- Give your feedback after each session.
- Give instructors feedback in real-time.

Too many sessions, too little time?

After AU visit:

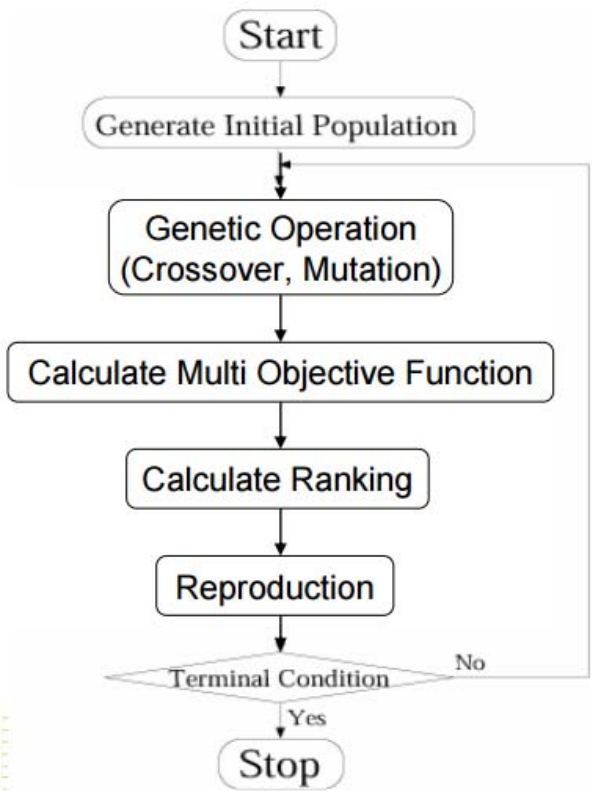
AutodeskUniversity.com

- Recorded sessions
- Presentations and handouts
- Key learnings

Don’t miss a second! Find hundreds of sessions waiting for you.

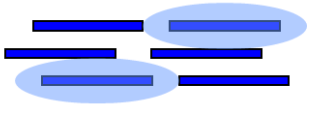
APPENDIX

MOGA-II



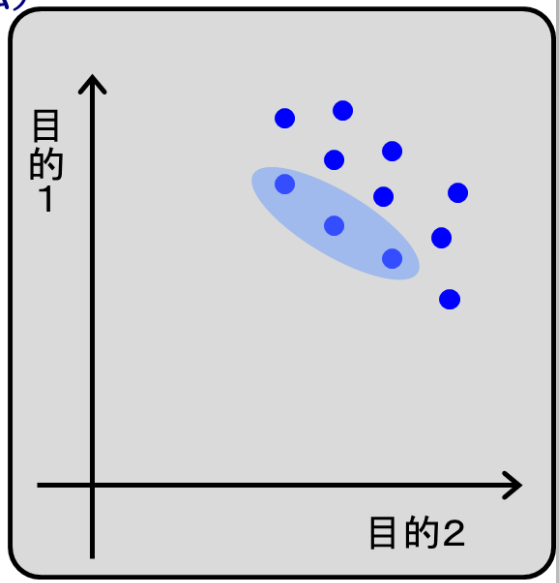
- MOGA(遺伝的アルゴリズム)

初期世代集団生成



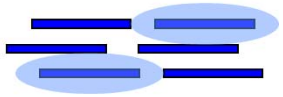
適合度計算

選択・交叉・突然変異



- MOGA(遺伝的アルゴリズム)

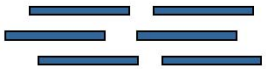
初期世代集団生成

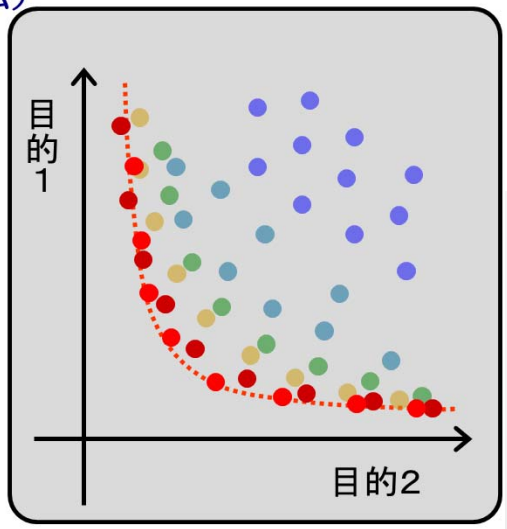


適合度計算

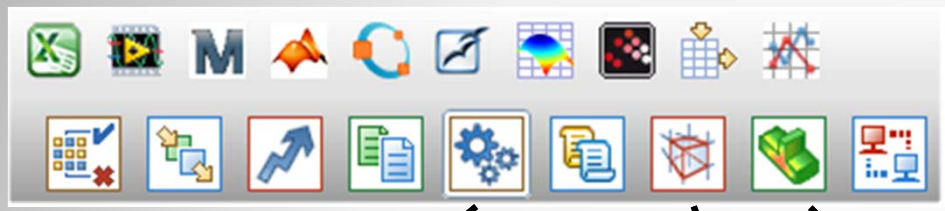
選択・交叉・突然変異

次世代集団生成

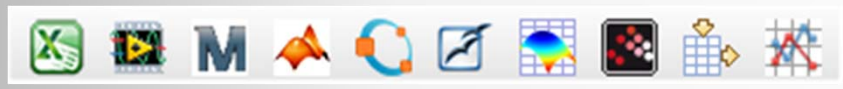




modeFrontier direct interface



APP



CAD

CAE

modeFRONTIER 実績
連成実績のある主なアプリケーション（抜粋）

熱流体解析
- STAR-CD
- SCRYU/Tetra
- FLOTHERM
- FLUENT
- CFX
- TascFlow
- FIDAP

構造解析
- MSC.NASTRAN
- MSC.MARC
- ABAQUS
- ANSYS
- ANSYS DesignSpace
- RADIOSS
- PAM/Crash
- LS-Dyna

機構解析
- MSC.ADAMS
- RecurDyn

CAD
- CATIA V4/V5
- UG
- IDEAS
- Pro/E
- SolidWorks
- O.S.M

解析Pre
- MSC.PATRAN
- ICEM CFD
- GridGen
- DEP Mesh Works/Morpher

その他の解析ツール
- GT-SUITE
- AVL Boost, Hydsim, Excite
- AMESim
- CarSim
- SPICE
- DYMOLA
- CHEMKIN
- Aspen Plus
- SYSNOISE
- TIMON
- Moldflow MPI
- JMAG / JMAG-RT
- PSIM
- MAGMA / MAGMAFrontier
- TOPCAST
- MATLAB/Simulink
- Microsoft Excel