



next stop: modelling of optical fabrication chains during optical design

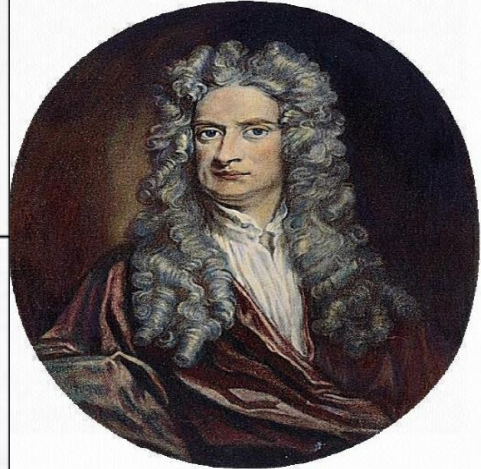


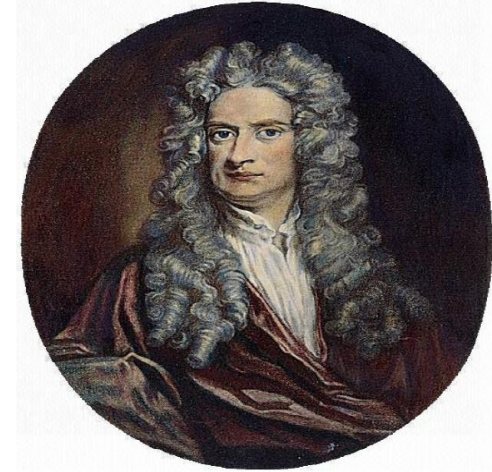
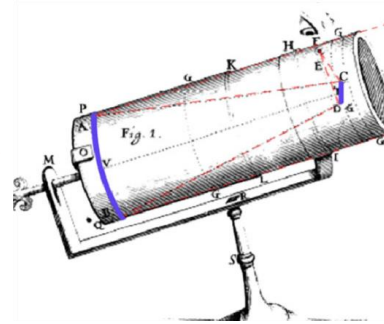
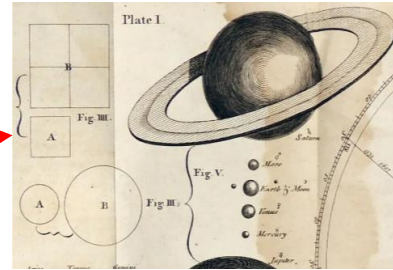
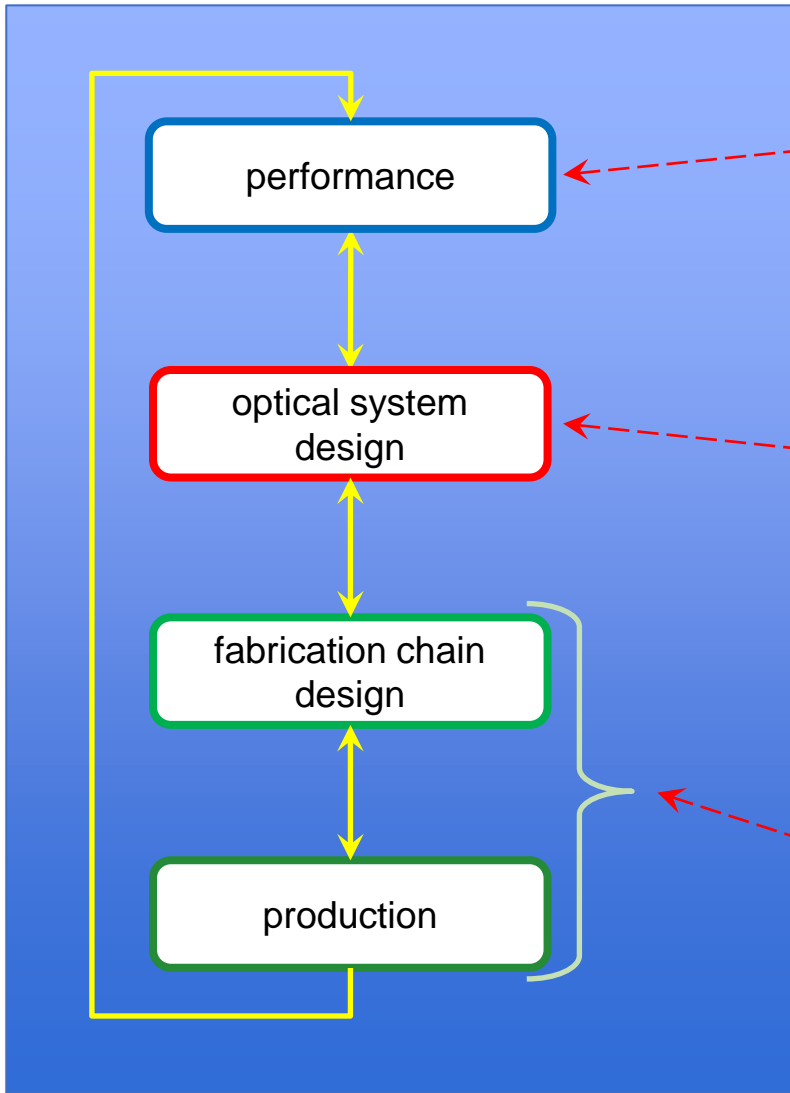
Oliver Faehnle

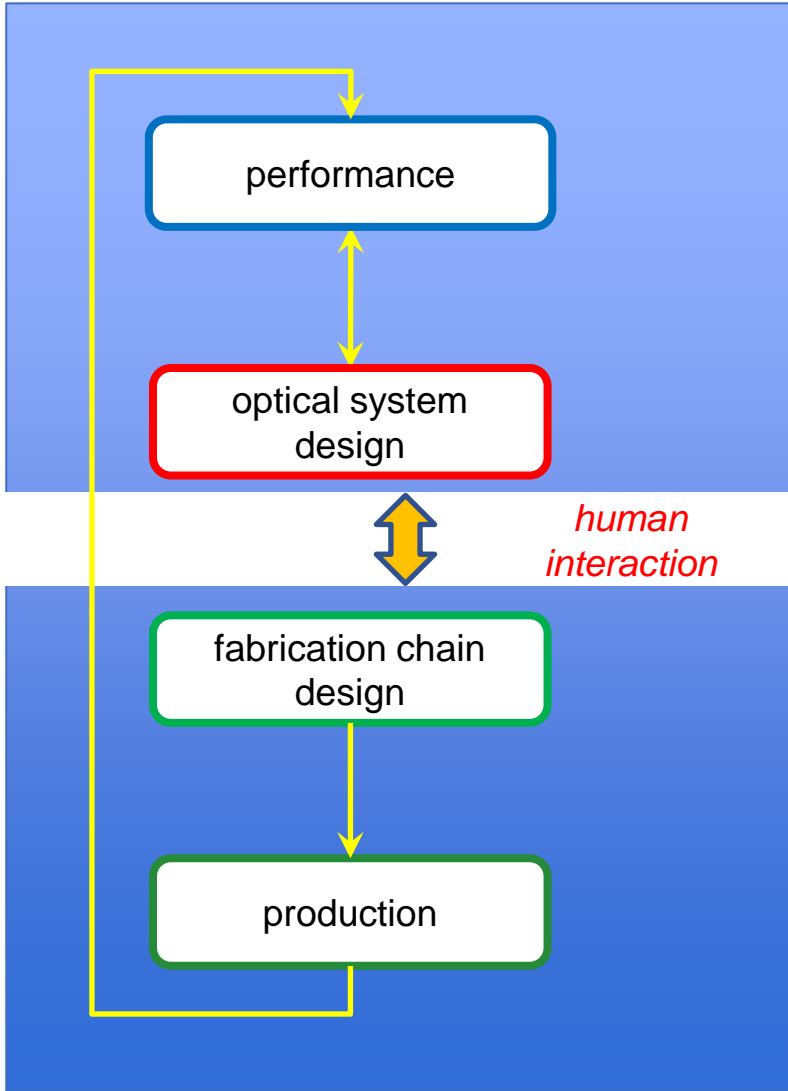


- Co-owner www.PanDao.ch, Switzerland
- fisba Head Optics Fabrication, OST University of Applied Sciences, Switzerland



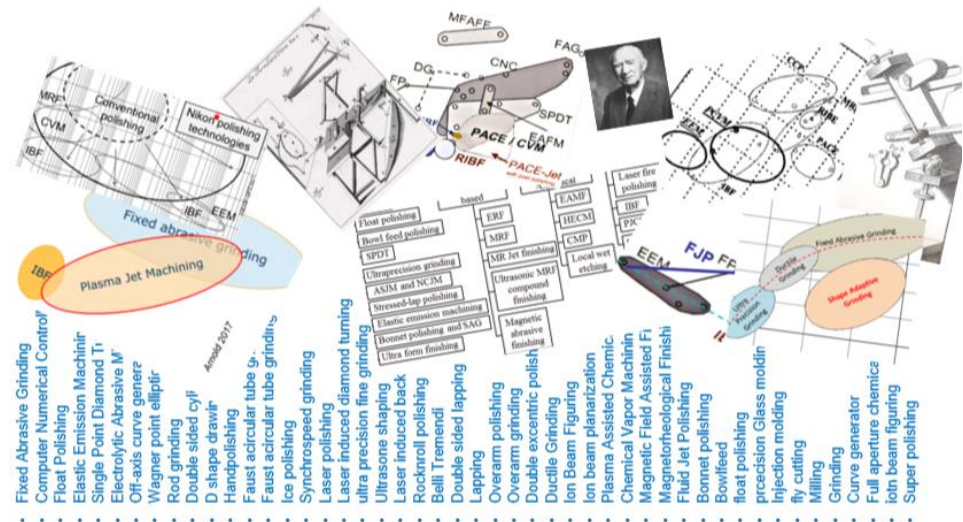


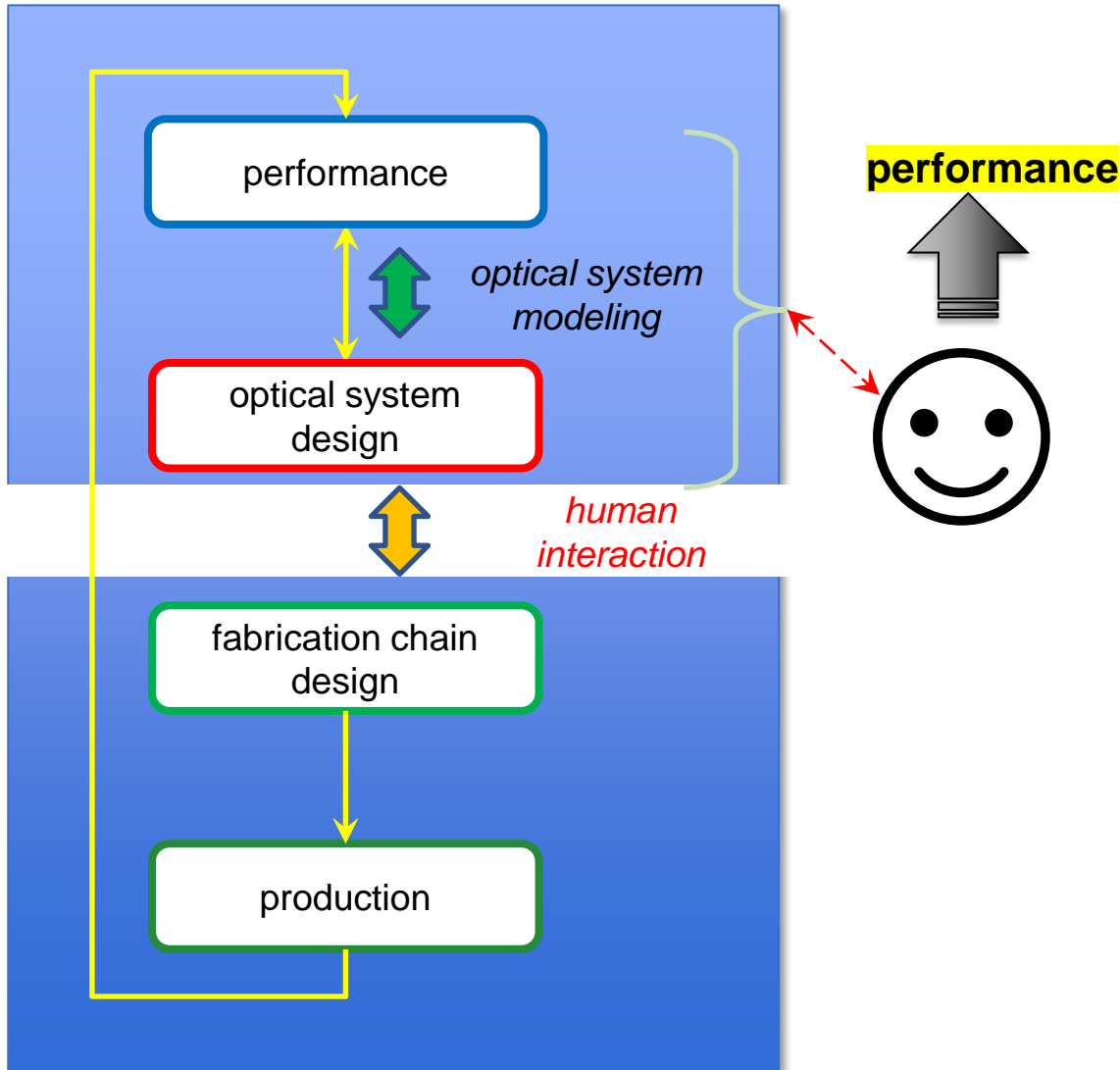




today

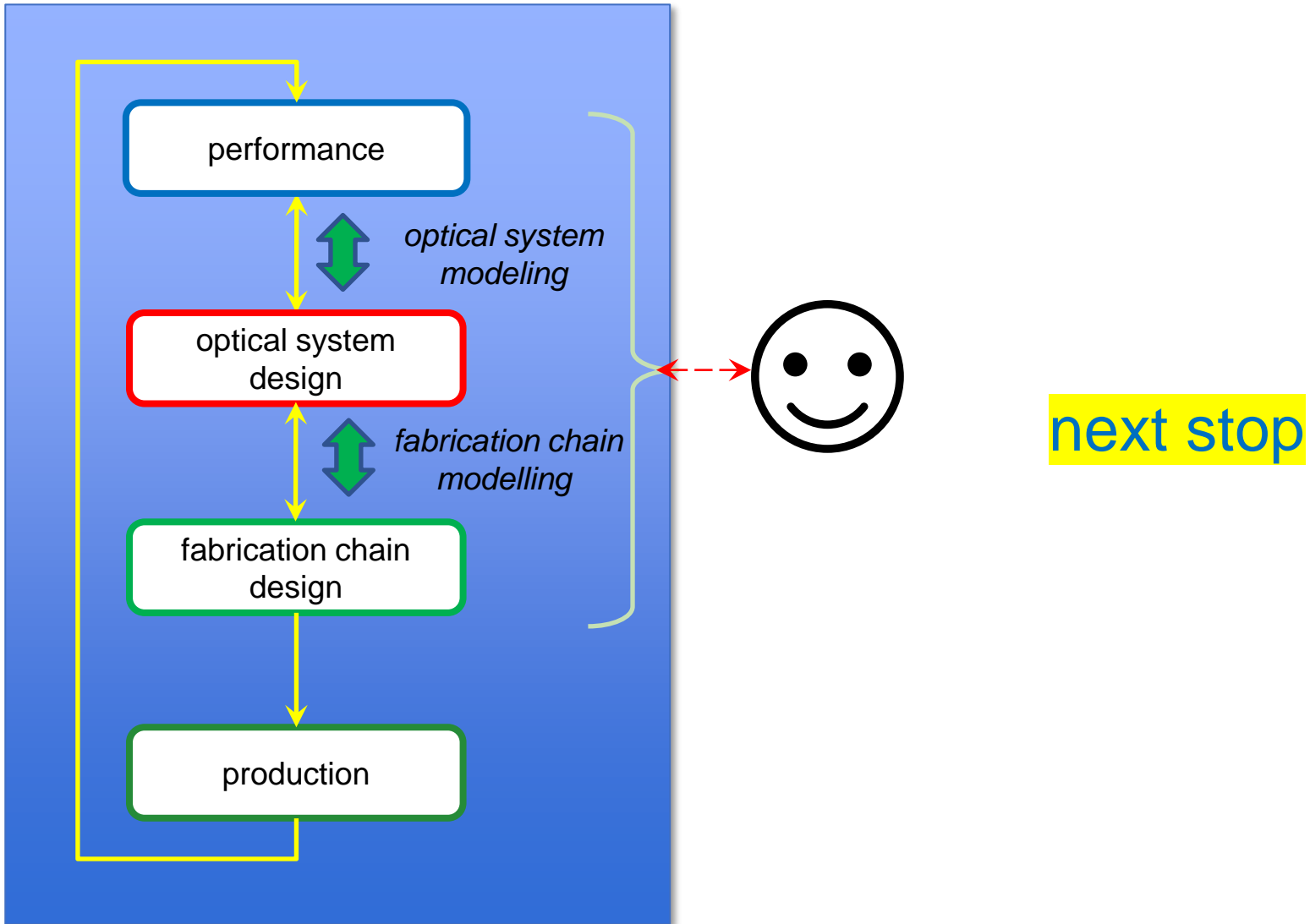
> 360 different Optical Fabrication Technologies

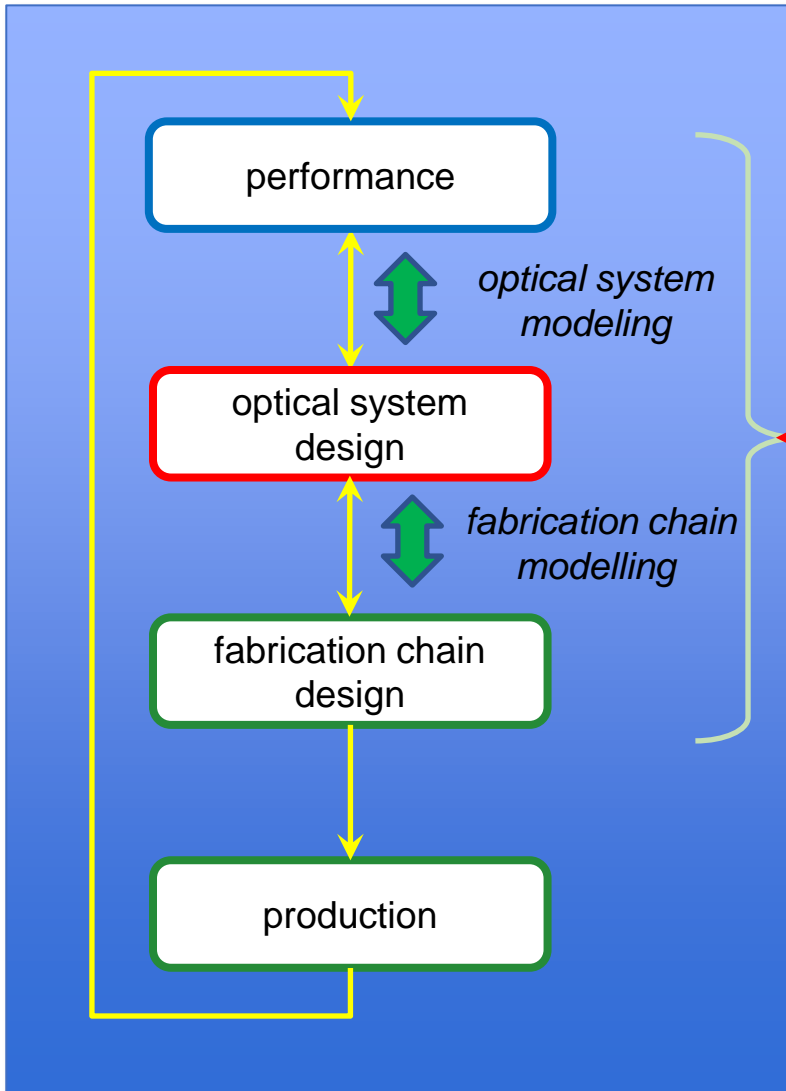




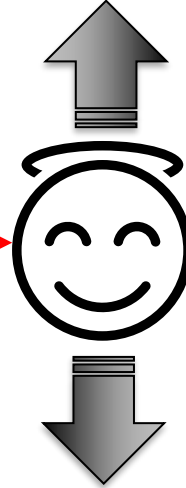
today

- design for best performance, only
- fab chain design after optical design has been finished
- fab feedback comes too late





performance



generation



next stop

- **balance** performance & generation
- modelling of best fab chain
- instant risk&cost impact analyses during optical design



fabrication risk & cost impact analyses

Name: Asphere	Description: Jose Pozo	Number of Sides: One	Material: glasses
Batch Size: 1000	Lens Diameter [mm]: 220	Center Thickness [mm]: 30	Knoop hardness (HK): 600
Total Number Of Lenses: 5000	Diameter Tolerance [mm]: 0.1	Center Thickness Tolerance [mm]: 0.05	Acid resistance (AR): AR1
<input type="checkbox"/> Suited for LIDT	<input type="checkbox"/> Outer cylinder length bigger lens diameter	<input type="checkbox"/> Material suited for precision glass molding	
Side 1			
Shape: aspheres	Defect Size(5/)[mm]: 0.063	Clear Aperture[mm]: 200	3/Power[fringes]: 3
Roughness: Custom (Sq [nr])	smallest midspatial wavelength accepted [mm]: 5	Decenter(4/)[min]: Specified: 1	3/Irregularity[fringes]: 2
Asphericity[um]: 100	Smallest Radius Of Curvature[mm]: 673	Concave parts included?: Not Included	
Radius of removal sphere[mm]: 660	Coating: Antireflex	Sagitta [mm]: 40	

Resulting most cost-efficient fabrication chain:

Side 1:

- cnc sub aperture rough grinding
- fabrication cost: 8.00€
- cnc sub aperture grinding
- ~~fabrication cost: 27.45€~~
- **ccp wheel polishing**
- fabrication cost: 80.26€

Cost 115.71€
Capability factor: 0.999
Chain uniqueness: 1

Total fabrication cost: **115.71€**
Serial batch lead time: 1.9573 days

- diam 220 mm, N-BK7, 2 lambda PV: 3/3(2)



fabrication risk & cost impact analyses

Name: Asphere	Description: Jose Pozo	Number of Sides: One	Material: glasses
Batch Size: 1000	Lens Diameter [mm]: 220	Center Thickness [mm]: 30	Knoop hardness (HK): 600
Total Number Of Lenses: 5000	Diameter Tolerance [mm]: 0.1	Center Thickness Tolerance [mm]: 0.05	Acid resistance (AR): AR1
<input type="checkbox"/> Suited for LIDT	<input type="checkbox"/> Outer cylinder length bigger lens diameter	<input type="checkbox"/> Material suited for precision glass molding	
Side 1			
Shape: aspheres	Defect Size(5/)[mm]: 0.063	Clear Aperture[mm]: 200	3/Power[fringes]: 1
Roughness: Custom (Sq [nr])	smallest midspatial wavelength accepted [mm]: 5	Decenter(4/)[min]: Specified: 1	3/Irregularity[fringes]: 0.2
Asphericity[um]: 100	Smallest Radius Of Curvature[mm]: 673	Concave parts included?: Not Included	
Radius of removal sphere[mm]: 660	Coating: Antireflex	Sagitta [mm]: 40	

Resulting most cost-efficient fabrication chain:

Side 1:

- cnc sub aperture rough grinding
• fabrication cost: 8.00€
- cnc sub aperture grinding
• fabrication cost: 27.45€
- **ccp wheel polishing**
• fabrication cost: 80.26€
- **ccp magnetorheological finishing**
• fabrication cost: 30.50€

Cost 146.21€
Capability factor: 1.000
Chain uniqueness: 5

Total fabrication cost: **146.21€**
Serial batch lead time: 1.9706 days

- diam 220 mm, N-BK7, 5th lambda PV: 3/1(0.2)



fabrication risk & cost impact analyses

Name:	Description:	Number of Sides:	Material:
Asphere	Jose Pozo	One	glasses
Batch Size:	Lens Diameter [mm]:	Center Thickness [mm]:	Knoop hardness (HK):
1000	220	30	600
Total Number Of Lenses:	Diameter Tolerance [mm]:	Center Thickness Tolerance [mm]:	Acid resistance (AR):
5000	0.1	0.05	AR1
<input type="checkbox"/> Suited for LIDT	<input type="checkbox"/> Outer cylinder length bigger lens diameter	<input type="checkbox"/> Material suited for precision glass molding	
Side 1			
Shape:	Defect Size(5/)[mm]:	Clear Aperture[mm]:	3/Power[fringes]:
aspheres	0.063	200	1
Roughness:	smallest midspatial wavelength accepted [mm]:	Decenter(4/)[min]:	3/Irregularity[fringes]:
Custom (Sq [nr]	5	Specified:	0.1
1			
Asphericity[um]:	Smallest Radius Of Curvature[mm]:	Concave parts included?	
100	673	Not Included	
Radius of removal sphere[mm]:	Coating:	Sagitta [mm]:	
660	Antireflex	40	

Resulting most cost-efficient fabrication chain:

Side 1:

- cnc sub aperture rough grinding
• fabrication cost: 8.00€
- cnc sub aperture grinding
• fabrication cost: 27.45€
- **ccp bonnet**
• fabrication cost: 88.14€
- **ccp ion beam figuring**
• fabrication cost: 39.54€

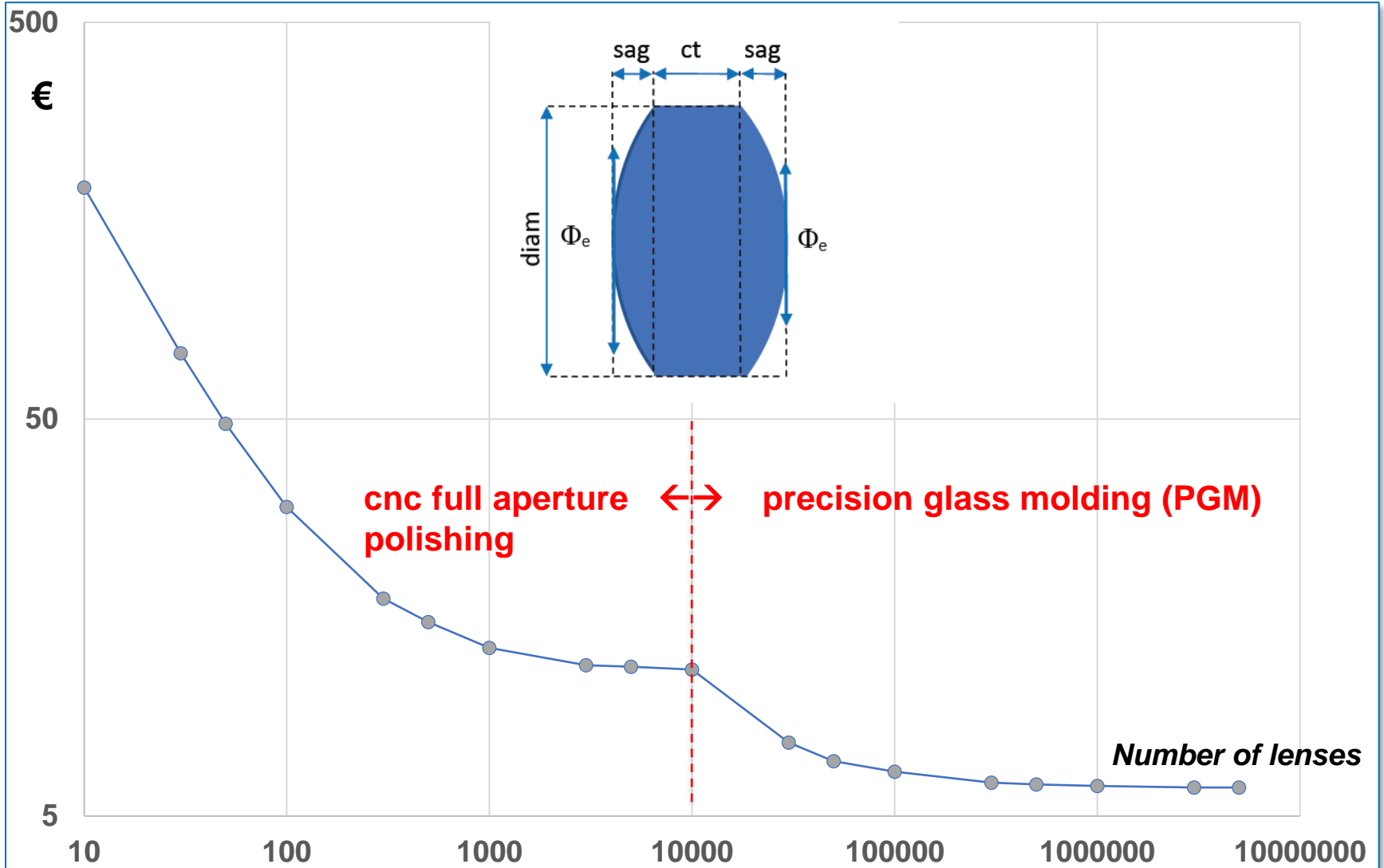
Cost 163.12€
Capability factor: 0.972
Chain uniqueness: 0

Total fabrication cost: **163.12€**
Serial batch lead time: 2.0417 days

- diam 220 mm, N-BK7, 10th lambda PV: 3/1(0.1)



product life cycle



*next stop: modelling of optical fabrication chains
during optical design*



