SKIVEALL – DESIGN OF POWER SKIVING PROCESSES

Presentation of the new software version 1.4

Webinar

March 23rd 2023

Fraunhofer IWU

AGENDA

- Why SkiveAll?
- Program structure
- New Features in V1.4
- Outlook
- SkiveAll 3D

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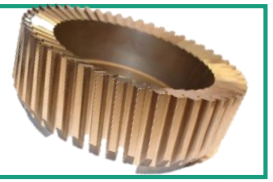
Scenario

1. Concept phase:

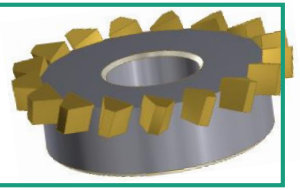
Manufacturer

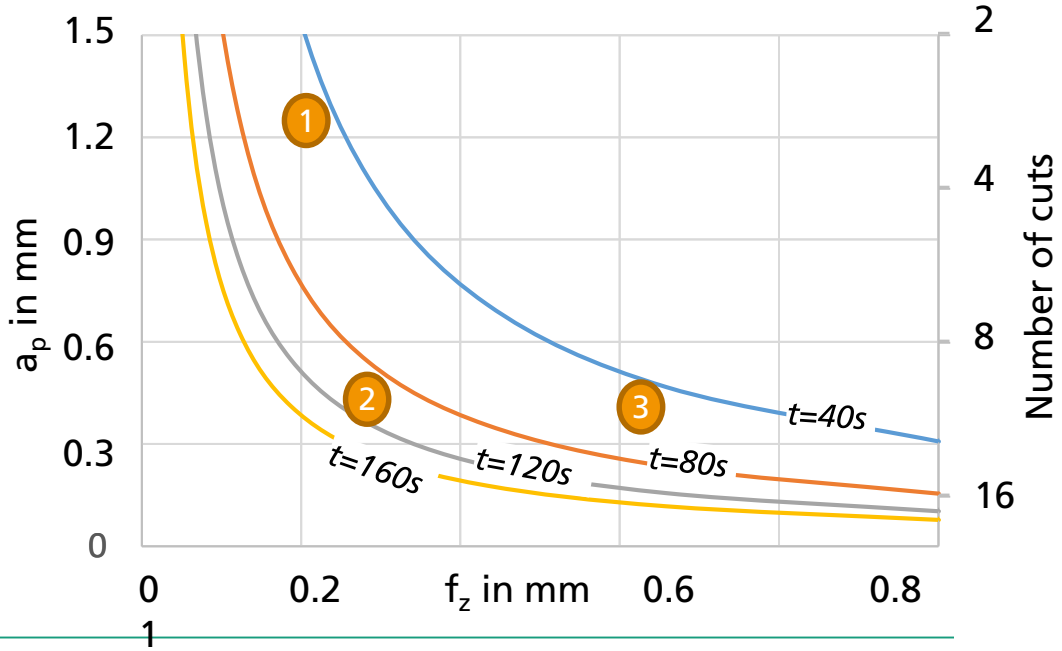
- Tool Supplier 1: $Z=43$, $\Sigma=20°$, $K=0°$

- Tool Supplier 2: $Z=45$, $\Sigma=20°$, $K=25°$



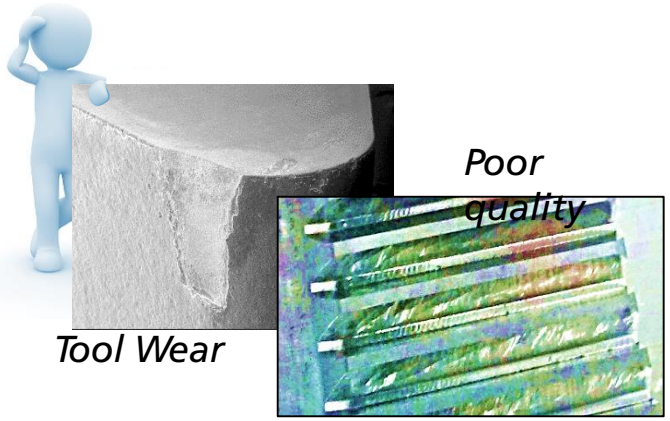
- Tool Supplier 3: $Z=25$, $\Sigma=15°$, $K=0°$





2. Tryout phase:

[Image: Liebherr]



Tool Wear

Poor quality

cost design clearance time cycle feed pattern rake flank rate profile deviation angle tool axis cross

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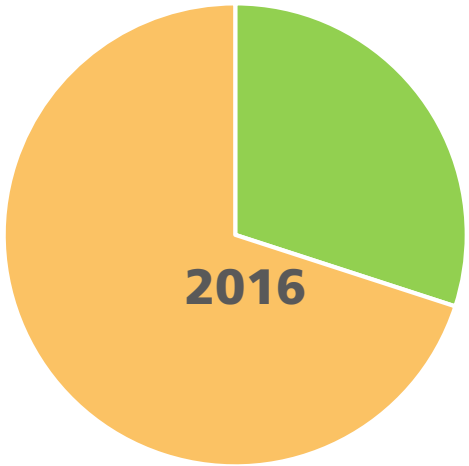
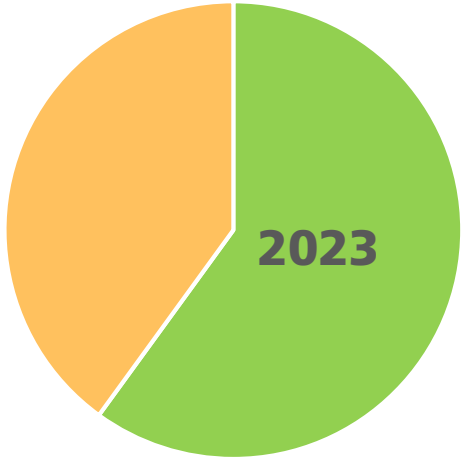
„Plug and Play“ – a Pipe Dream for Power Skiving?

„Plug & play“ use case

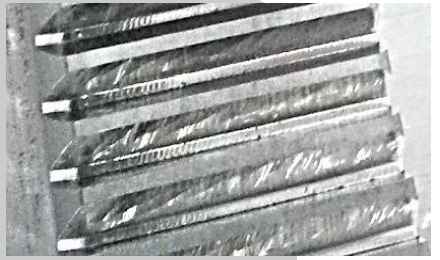
- First tool design
- Technology design
- Running!





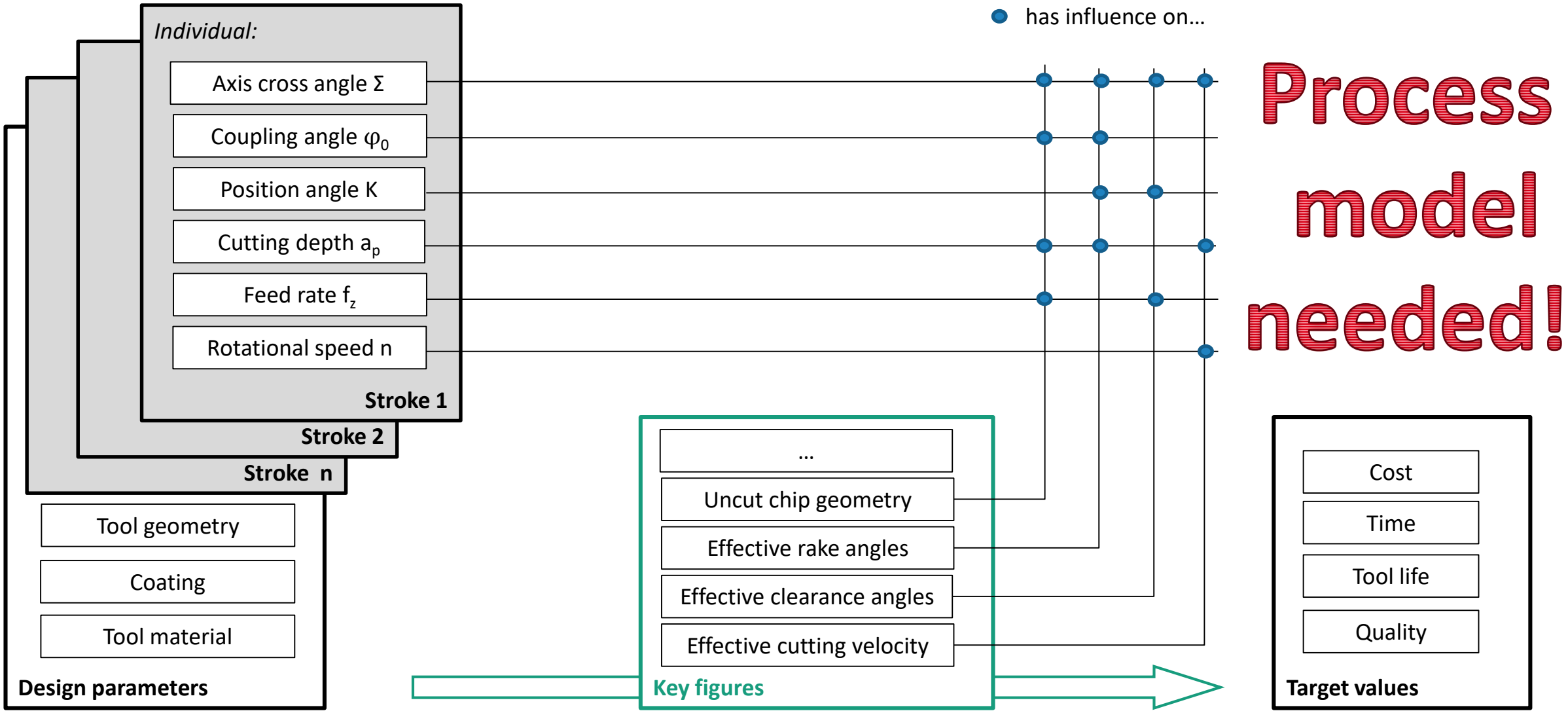
How to reach the 95% level?

Harder use case



- First tool design
- Tryout fail
- Second tool design
- Tryout
- Optimization
- Running !

Figure-Based Power Skiving Process Design



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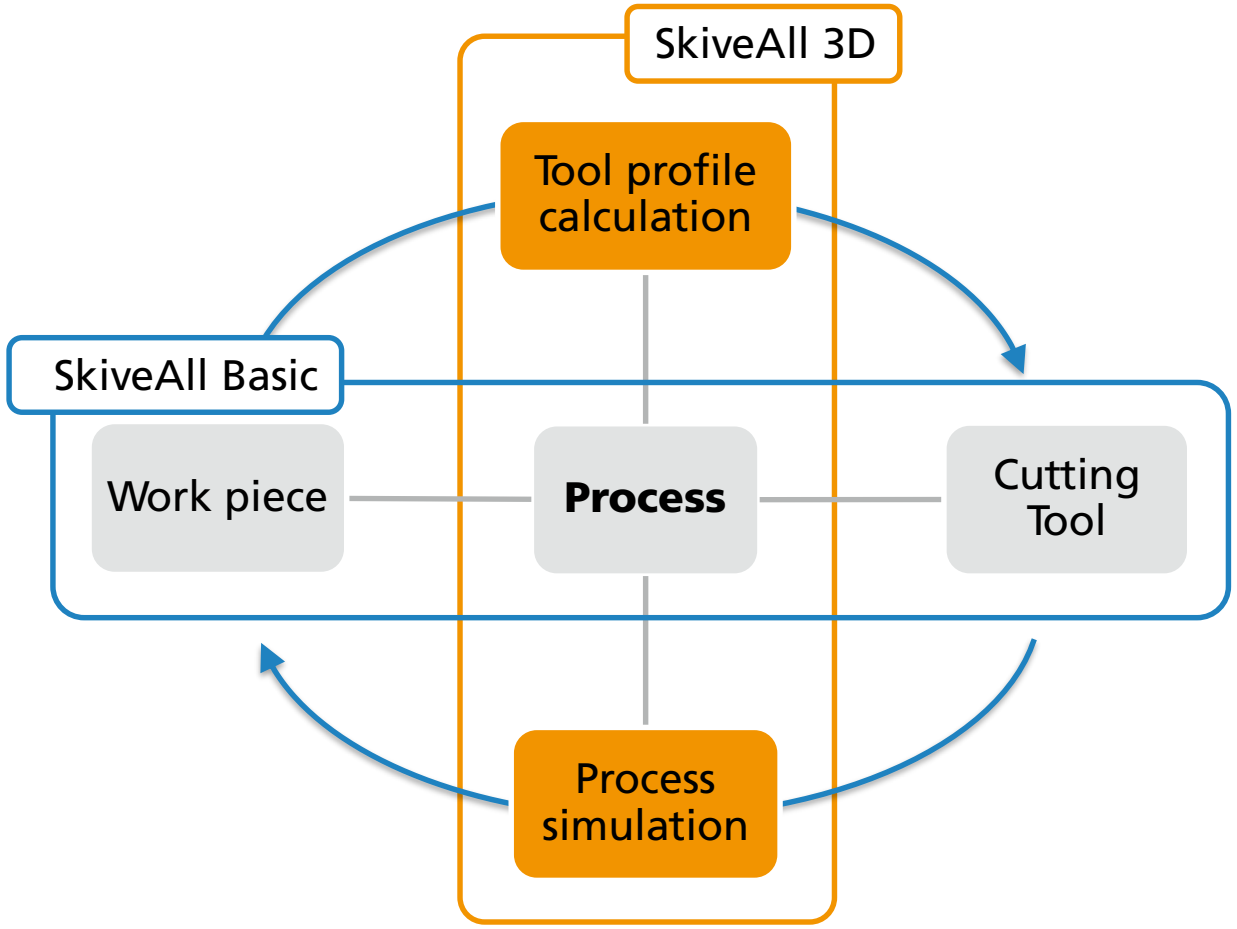
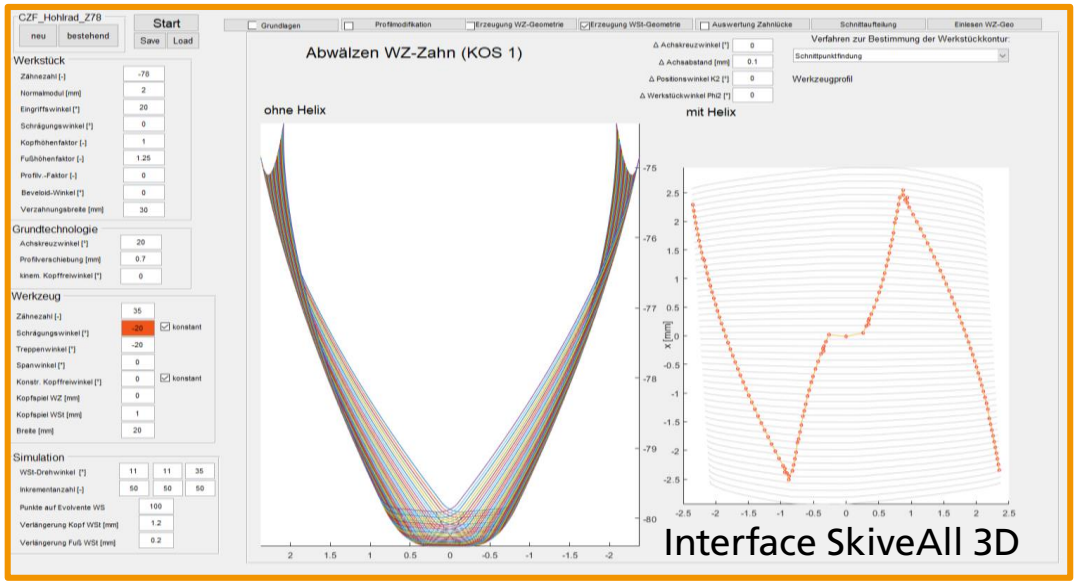
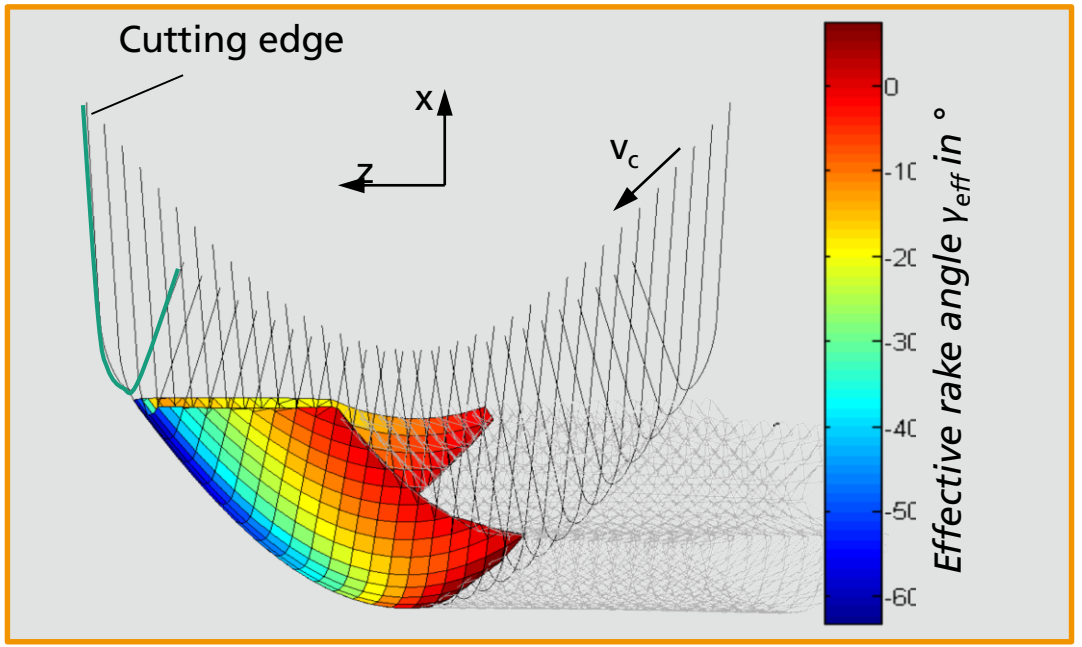
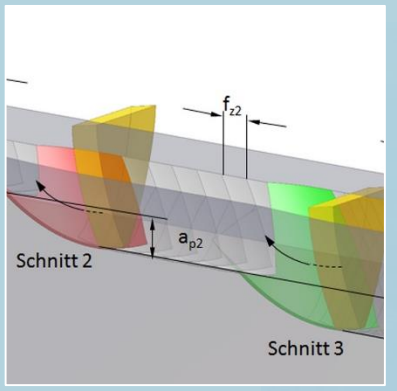
Process model and und software modules





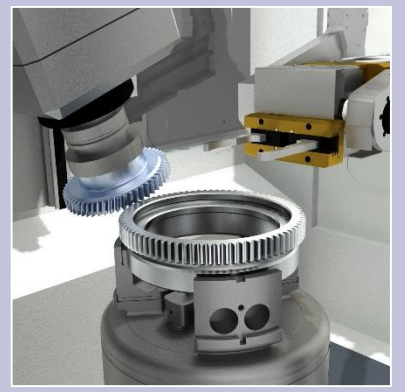


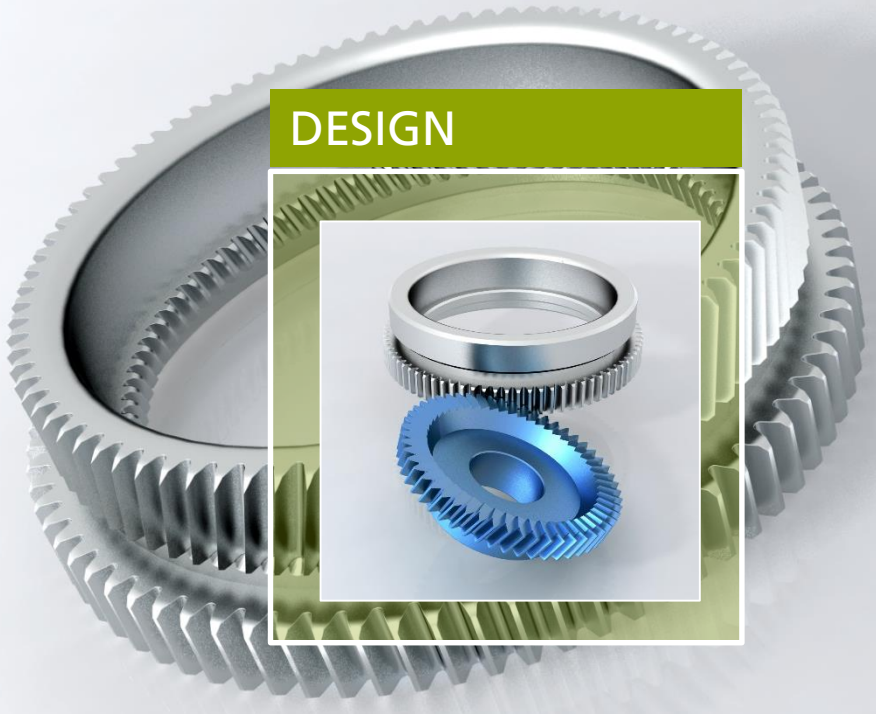
What to consider?



PROCESS

MACHINE

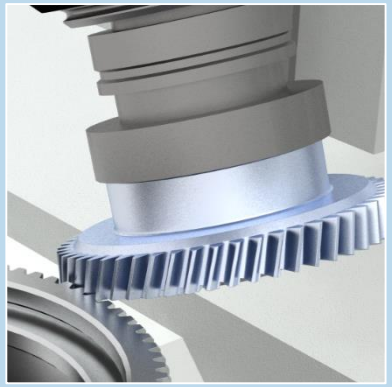




DESIGN

WORK PIECE

CUTTING TOOL



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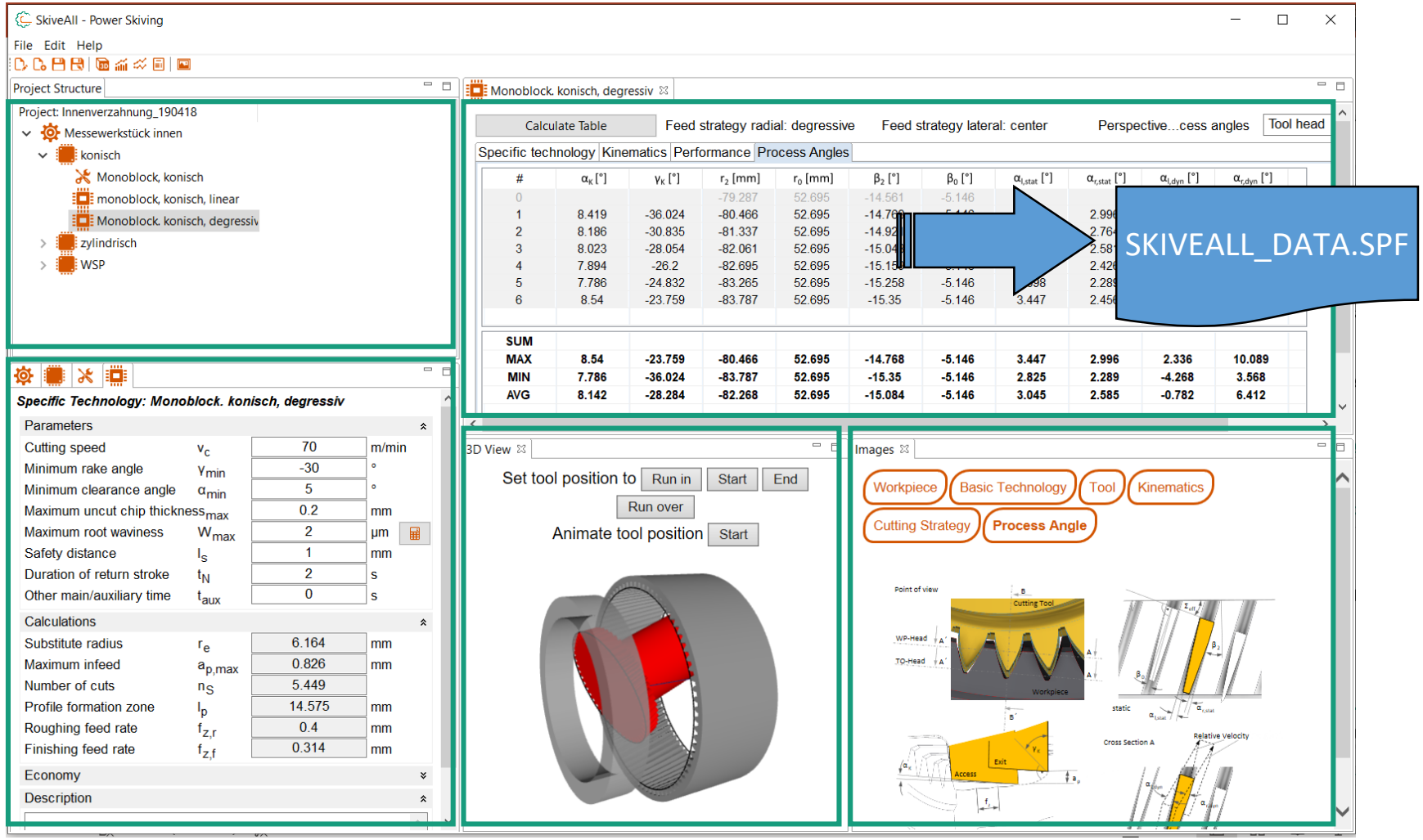
Process Design with SkiveAll

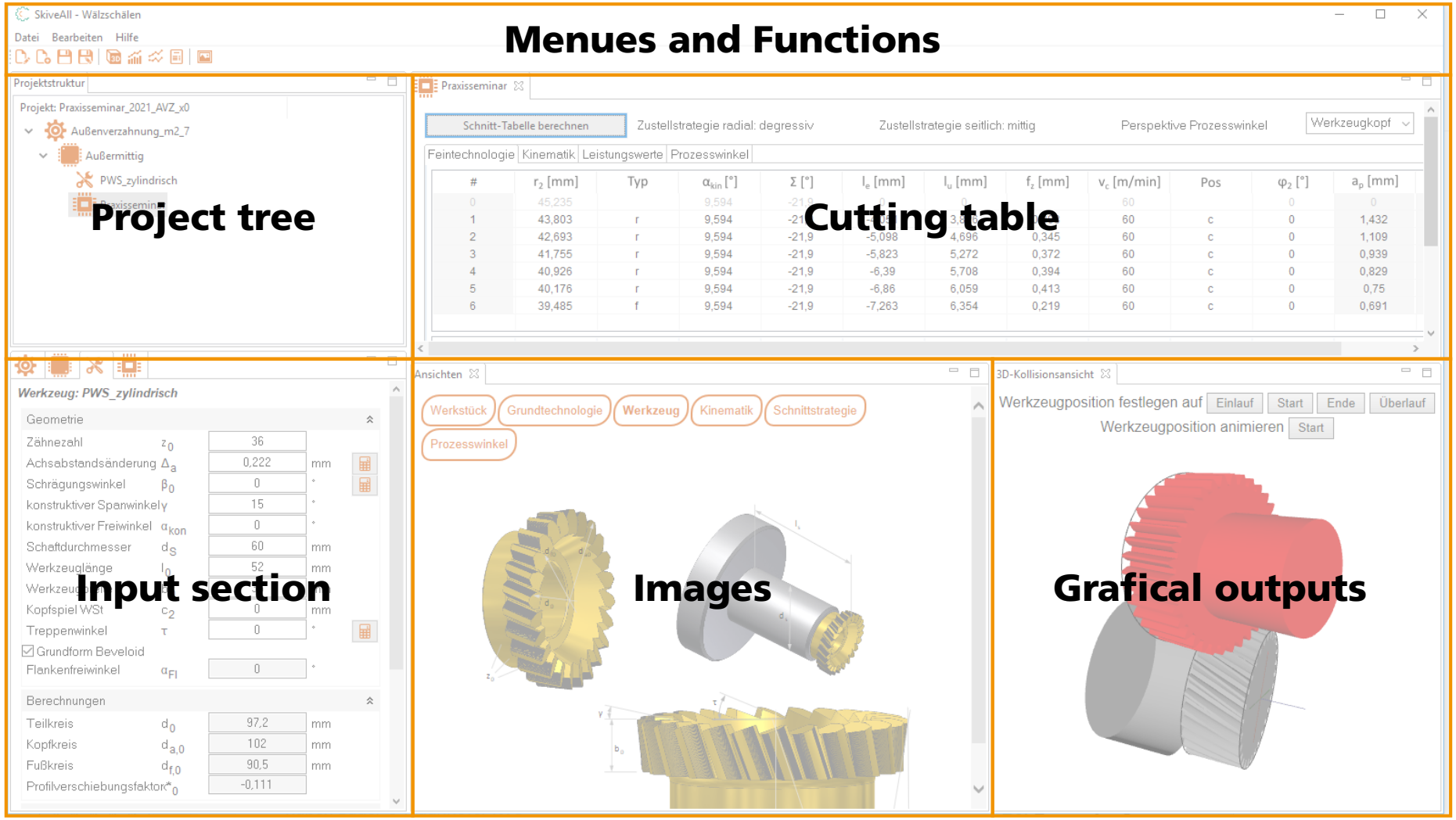


#	α_k [°]	γ_k [°]	r_2 [mm]	r_0 [mm]	β_2 [°]	β_0 [°]	$\alpha_{l,stat}$ [°]	$\alpha_{r,stat}$ [°]	$\alpha_{l,dyn}$ [°]	$\alpha_{r,dyn}$ [°]
0			-79.287	52.695	-14.561	-5.146				
1	8.419	-36.024	-80.466	52.695	-14.768			2.996		
2	8.186	-30.835	-81.337	52.695	-14.92			2.764		
3	8.023	-28.054	-82.061	52.695	-15.04			2.581		
4	7.894	-26.2	-82.695	52.695	-15.15			2.426		
5	7.786	-24.832	-83.265	52.695	-15.258	-5.146	3.698	2.289		
6	8.54	-23.759	-83.787	52.695	-15.35	-5.146	3.447	2.456		
SUM										
MAX	8.54	-23.759	-80.466	52.695	-14.768	-5.146	3.447	2.996	2.336	10.089
MIN	7.786	-36.024	-83.787	52.695	-15.35	-5.146	2.825	2.289	-4.268	3.568
AVG	8.142	-28.284	-82.268	52.695	-15.084	-5.146	3.045	2.585	-0.782	6.412

Cutting speed	v_c	70	m/min
Minimum rake angle	γ_{min}	-30	°
Minimum clearance angle	α_{min}	5	°
Maximum uncut chip thickness	$_{max}$	0.2	mm
Maximum root waviness	W_{max}	2	µm
Safety distance	l_s	1	mm
Duration of return stroke	t_N	2	s
Other main/auxiliary time	t_{aux}	0	s
Substitute radius	r_e	6.164	mm
Maximum infeed	$a_{p,max}$	0.826	mm
Number of cuts	n_S	5.449	
Profile formation zone	l_p	14.575	mm
Roughing feed rate	$f_{z,r}$	0.4	mm
Finishing feed rate	$f_{z,f}$	0.314	mm

- Step 1: Draft of a *basic technology* and tool in variants (Σ, K, z_{to}, β_{to})
- Step 2: *Evaluation* by collision analysis and error prediction
- Step 3: Derivation of various *cutting strategies* (number of cuts, f_z, v_c, …)
- Step 4: Figure-based *optimization of* technology parameters for each cut (Σ_i, K_i, n_i,…)
- Step 5: *Export* of the entire technology
  - as .csv (e.g. for MS EXCEL, …)
  - as CNC program

User interface SkiveAll



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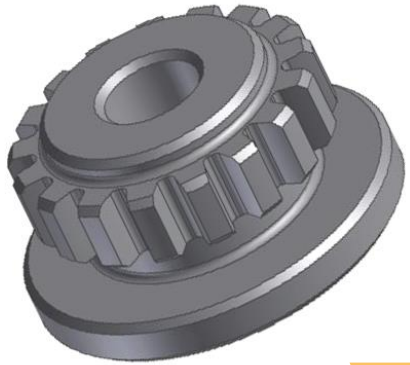
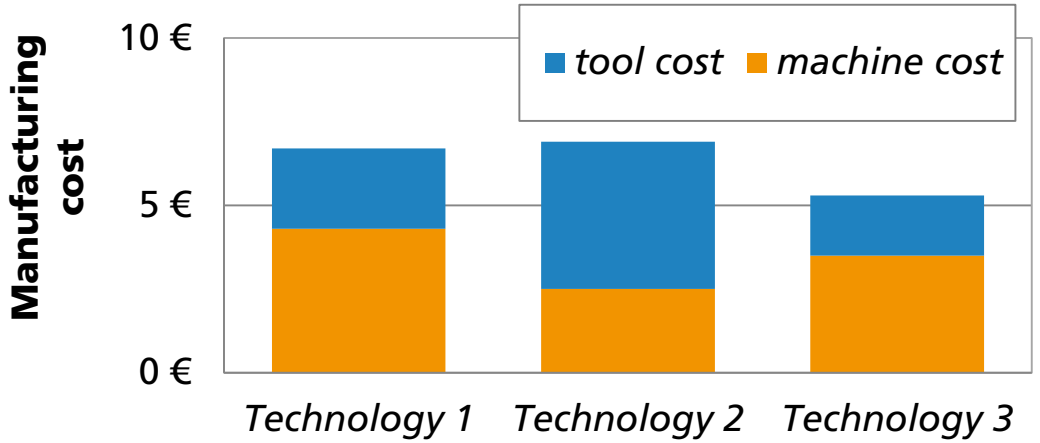
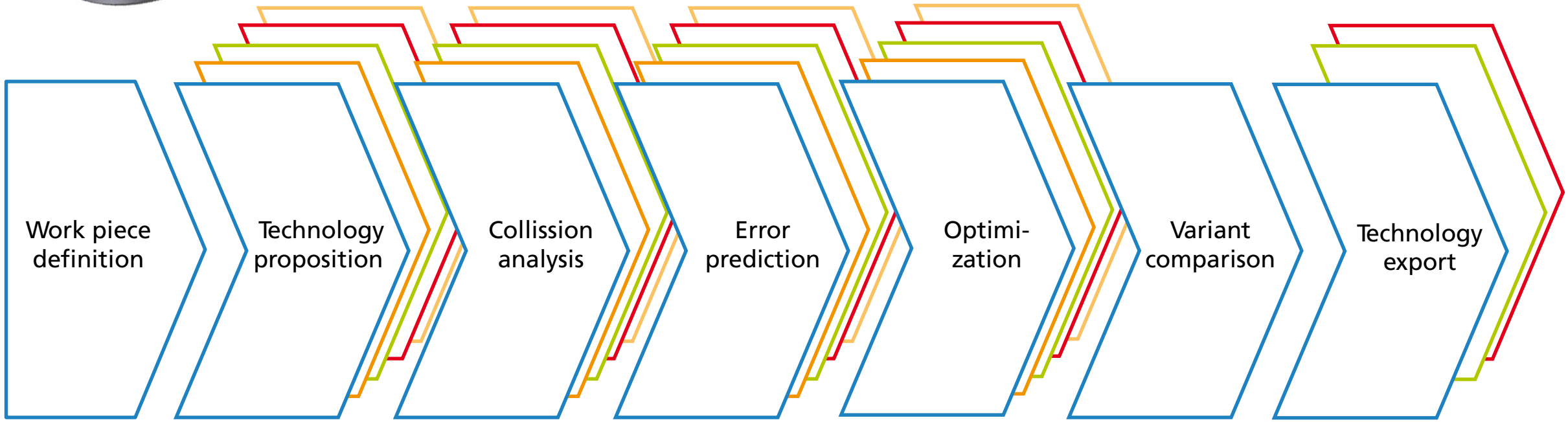
Workflow







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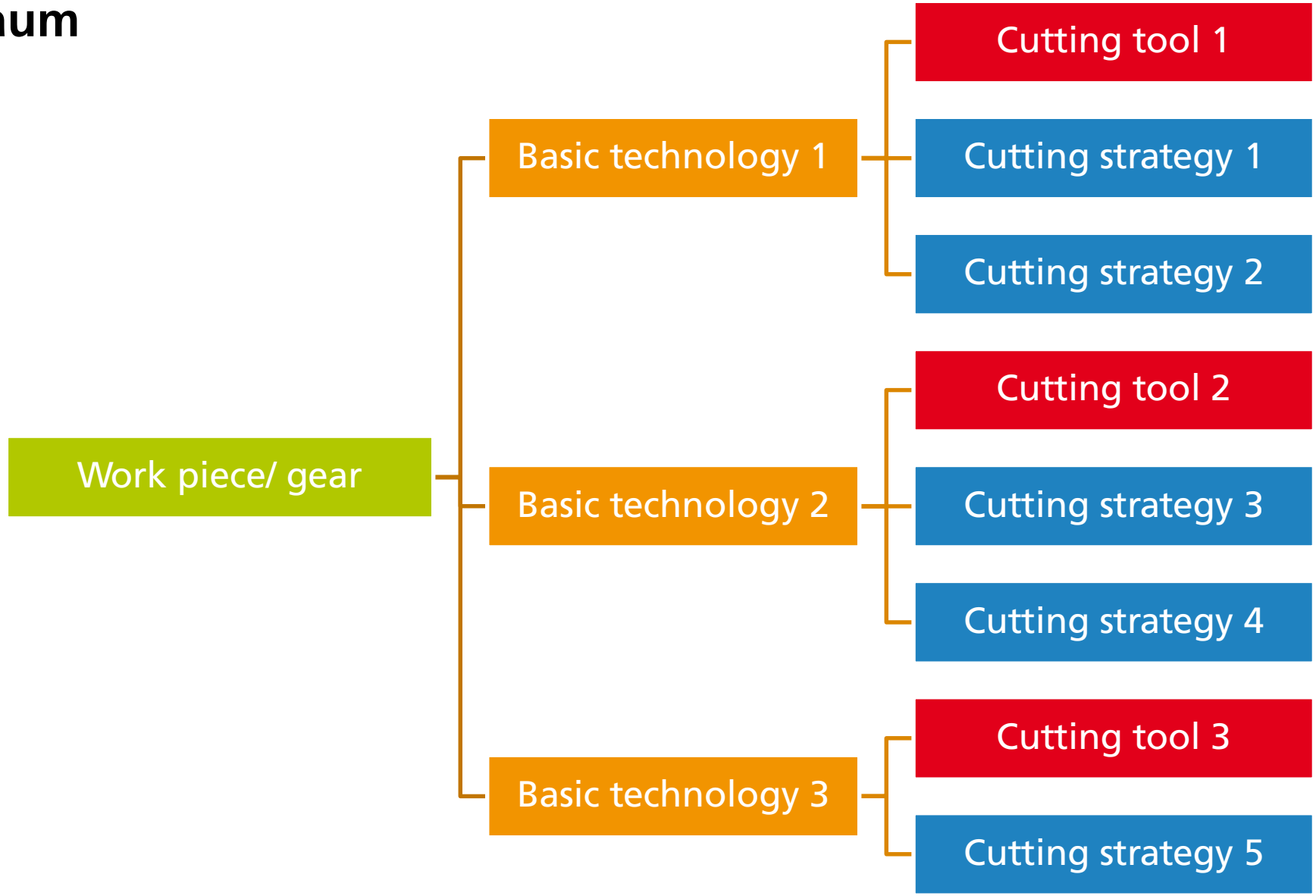
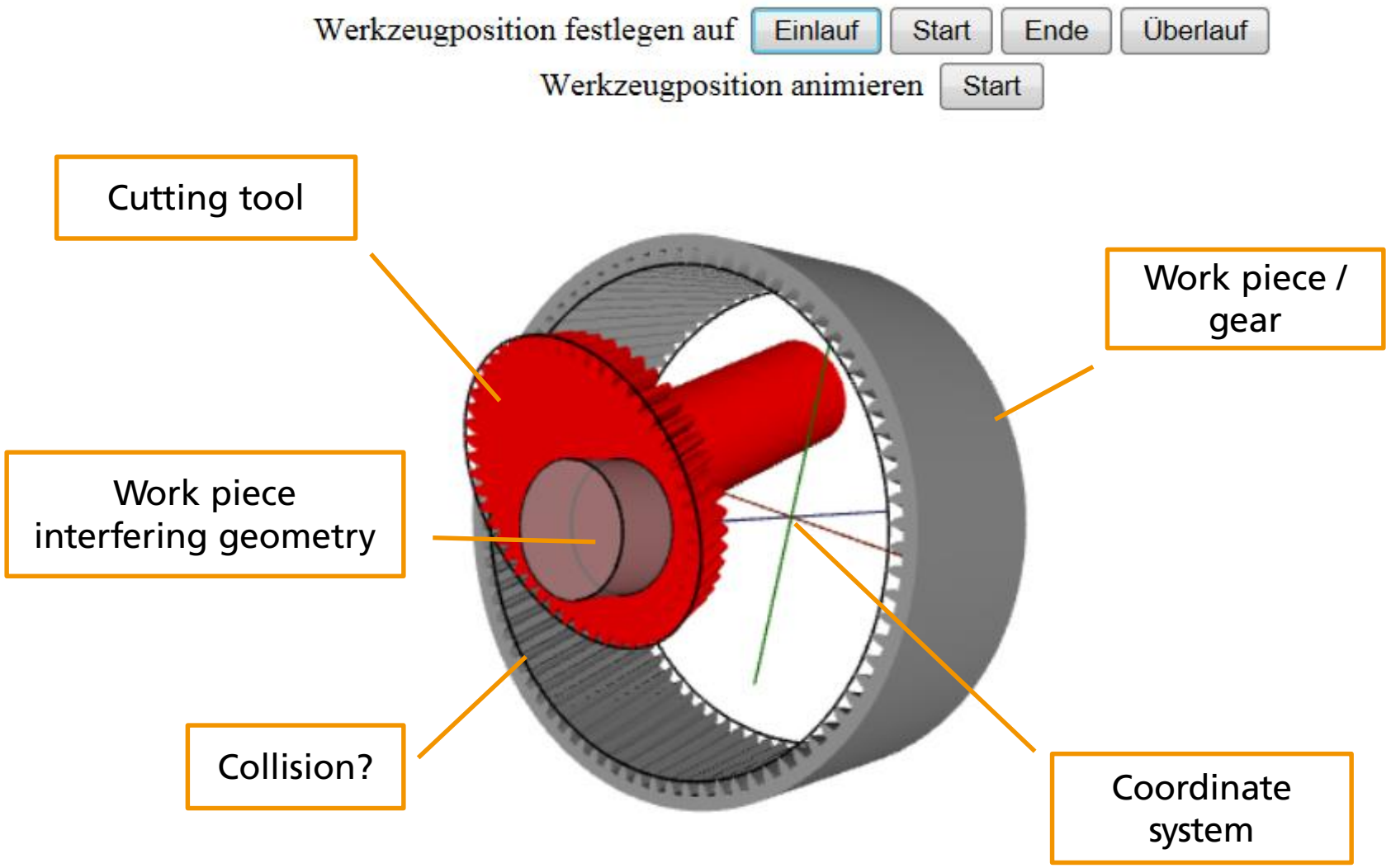
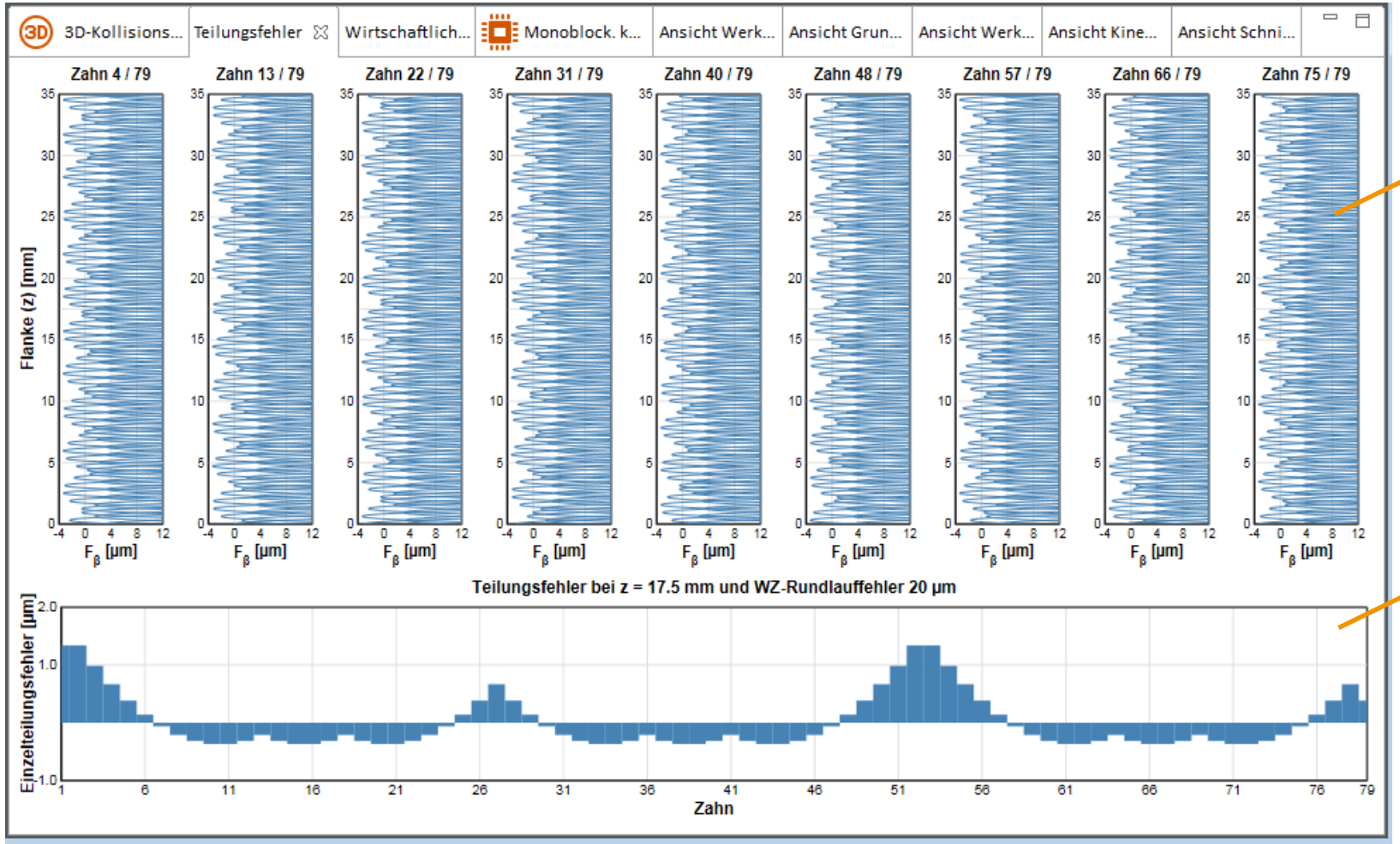
Projektbaum



Window „3D-Collision Analysis“



Window „Errror prediction“



Prediction lead error

Prediction pitch error

Cutting Table

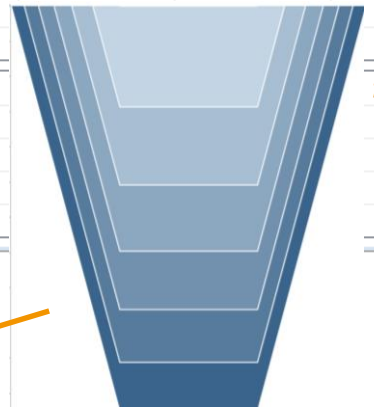
Tab for parameter groups

Cuts 1 bis n

Graph of cuts

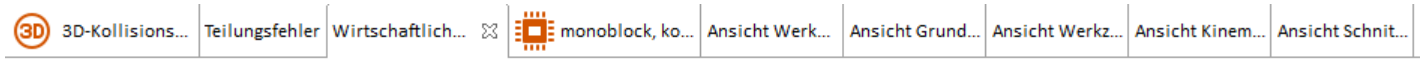
Feintechnologie | Kinematik | Leistungswerte | Prozesswinke

#	r_2 [mm]	Typ	α_{kin} [°]	Σ [°]	l_e [mm]	l_u [mm]	f_z [mm]	v_c [m/min]	Pos	φ_2 [°]	a_p [mm]	T [s]
0	33,058											
1	32,608	r	10	-18	-1,201	1,149	0,417	100	c	0	0,45	4,029
2	32,159	r	10	-18	-1,699	1,58	0,417	100	c	0	0,45	4,098
3	31,708	r	10	-18	-2,089	1,907	0,417	100	c	0	0,45	4,151
4	31,258	r	10	-18	-2,422	2,18	0,417	100	c	0	0,45	4,196
5	30,809	r	10	-18	-2,719	2,415	0,417	100	c	0	0,45	4,236
6	30,358	r	10	-18	-2,989	2,624	0,417	100	c	0	0,45	4,271
7	29,908	r	10	-18	-3,238	2,813	0,417	100	c	0	0,45	4,304
8	29,458	r	10	-18	-3,468	2,986	0,417	100	c	0	0,45	4,334
9	29,008	r	10	-18	-3,689	3,147	0,417	100	c	0	0,45	4,362
10	28,558	f	10			3,295	0,297	100	c	0	0,45	5,356
SUM						**24,095**					**4,5**	**43,338**
MAX	**33,058**		**10**			**3,295**	**0,417**	**100**		**0**	**0,45**	**5,356**
MIN	**28,558**		**10**			**1,149**	**0,297**	**100**		**0**	**0,45**	**4,029**
AVG	**30,809**		**10**			**2,41**	**0,405**	**100**		**0**	**0,45**	**4,334**



Variant comparison

Variants



Kosten pro Teil [€]

Technologie	Maschine [€]	Personal [€]	Werkzeug [€]	Gesamt [€]
monoblock, konisch, linear	3,04	0,59	17,24	20,87
Monoblock. konisch, degressiv	3,49	0,63	17,24	21,36
monoblock, zylindrisch, linear	4,34	0,78	14,17	19,29
Monoblock, zylindrisch, degressiv	4,37	0,79	14,17	19,33
WSP, linear	2,15	0,39	10	12,54
WSP, degressiv	2,24	0,4	10	12,64

Cost

Zeiten [h:min:s]

Technologie	Fertigung [h:min:s]	Werkzeugwechsel [h:min:s]
monoblock, konisch, linear	00:03:02	01:28:09
Monoblock. konisch, degressiv	00:03:13	01:33:29
monoblock, zylindrisch, linear	[illegible]	02:00:19
Monoblock, zylindrisch, degressiv	[illegible]	02:01:09
WSP, linear	00:01:59	00:57:36
WSP, degressiv	00:02:04	00:59:59

Duration

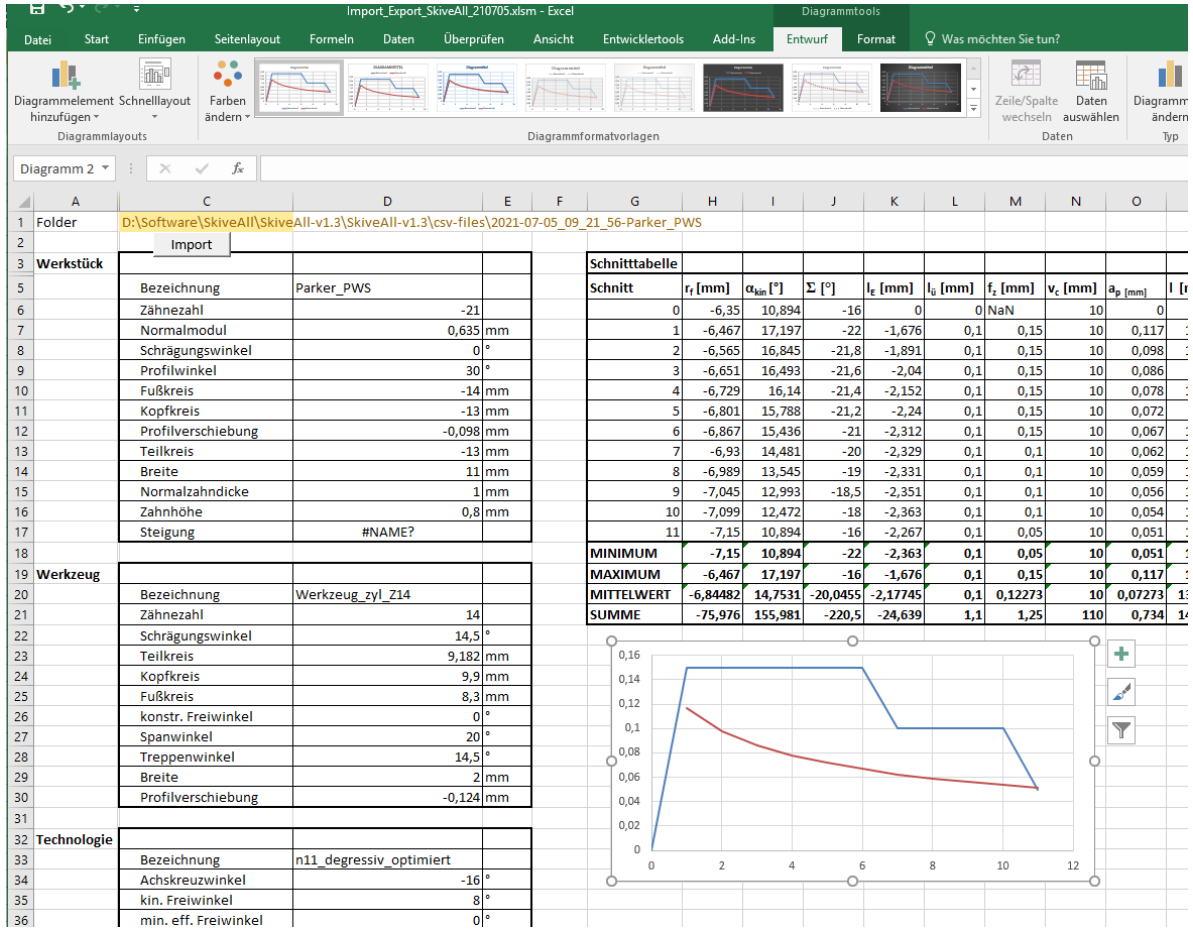
Werkzeug

Technologie	Standlänge [mm]	Nachschliffintervall [Teile]	Gesamtstückzahl [Teile]
monoblock, konisch, linear	1885	29	145
Monoblock. konisch, degressiv	1885	29	145
monoblock, zylindrisch, linear	[illegible]	[illegible]	600
Monoblock, zylindrisch, degressiv	1950	30	600
WSP, linear	1885	29	2900
WSP, degressiv	1885	29	2900

Tool performance

Export

a) all Data to **Excel**



Import_Export_SkiveAll_210705.xlsm - Excel

Folder: D:\Software\SkiveAll\SkiveAll-v1.3\SkiveAll-v1.3\csv-files\2021-07-05_09_21_56-Parker_PWS

Import

Werkstück			
	Bezeichnung	Parker_PWS	
	Zähnezahl	-21	
	Normalmodul	0,635	mm
	Schrägungswinkel	0	°
	Profilwinkel	30	°
	Fußkreis	-14	mm
	Kopfkreis	-13	mm
	Profilverschiebung	-0,098	mm
	Teilkreis	-13	mm
	Breite	11	mm
	Normalzahndicke	1	mm
	Zahnhöhe	0,8	mm
	Steigung	#NAME?	
Werkzeug			
	Bezeichnung	Werkzeug_zyl_Z14	
	Zähnezahl	14	
	Schrägungswinkel	14,5	°
	Teilkreis	9,182	mm
	Kopfkreis	9,9	mm
	Fußkreis	8,3	mm
	konstr. Freiwinkel	0	°
	Spanwinkel	20	°
	Treppenwinkel	14,5	°
	Breite	2	mm
	Profilverschiebung	-0,124	mm
Technologie			
	Bezeichnung	n11_degressiv_optimiert	
	Achskreuzwinkel	-16	°
	kin. Freiwinkel	8	°
	min. eff. Freiwinkel	0	°

Schnitttabelle

Schnitt	r_f [mm]	α_{kin} [°]	Σ [°]	l_E [mm]	$l_ü$ [mm]	f_z [mm]	v_c [mm]	a_p [mm]
0	-6,35	10,894	-16	0	0	NaN	10	0
1	-6,467	17,197	-22	-1,676	0,1	0,15	10	0,117
2	-6,565	16,845	-21,8	-1,891	0,1	0,15	10	0,098
3	-6,651	16,493	-21,6	-2,04	0,1	0,15	10	0,086
4	-6,729	16,14	-21,4	-2,152	0,1	0,15	10	0,078
5	-6,801	15,788	-21,2	-2,24	0,1	0,15	10	0,072
6	-6,867	15,436	-21	-2,312	0,1	0,15	10	0,067
7	-6,93	14,481	-20	-2,329	0,1	0,1	10	0,062
8	-6,989	13,545	-19	-2,331	0,1	0,1	10	0,059
9	-7,045	12,993	-18,5	-2,351	0,1	0,1	10	0,056
10	-7,099	12,472	-18	-2,363	0,1	0,1	10	0,054
11	-7,15	10,894	-16	-2,267	0,1	0,05	10	0,051
MINIMUM	**-7,15**	**10,894**	**-22**	**-2,363**	**0,1**	**0,05**	**10**	**0,051**
MAXIMUM	**-6,467**	**17,197**	**-16**	**-1,676**	**0,1**	**0,15**	**10**	**0,117**
MITTELWERT	**-6,84482**	**14,7531**	**-20,0455**	**-2,17745**	**0,1**	**0,12273**	**10**	**0,07273**
SUMME	**-75,976**	**155,981**	**-220,5**	**-24,639**	**1,1**	**1,25**	**110**	**0,734**

b) Parameters as **CNC program**

```
_SK_R2[8]=-6.989;FUSSKREISRADIUS[8]
_SK_R2[9]=-7.045;FUSSKREISRADIUS[9]
_SK_R2[10]=-7.099;FUSSKREISRADIUS[10]
_SK_R2[11]=-7.15;FUSSKREISRADIUS[11]
;ALPHAKIN[0]=10.894;
;ALPHAKIN[1]=17.197;
;ALPHAKIN[2]=16.845;
;ALPHAKIN[3]=16.493;
;ALPHAKIN[4]=16.14;
;ALPHAKIN[5]=15.788;
;ALPHAKIN[6]=15.436;
;ALPHAKIN[7]=14.481;
;ALPHAKIN[8]=13.545;
;ALPHAKIN[9]=12.993;
;ALPHAKIN[10]=12.472;
;ALPHAKIN[11]=10.894;
_SK_SIGMA[0]=-16;ACHSKREUZWINKEL[0]
_SK_SIGMA[1]=-22;ACHSKREUZWINKEL[1]
_SK_SIGMA[2]=-21.8;ACHSKREUZWINKEL[2]
_SK_SIGMA[3]=-21.6;ACHSKREUZWINKEL[3]
_SK_SIGMA[4]=-21.4;ACHSKREUZWINKEL[4]
_SK_SIGMA[5]=-21.2;ACHSKREUZWINKEL[5]
_SK_SIGMA[6]=-21;ACHSKREUZWINKEL[6]
_SK_SIGMA[7]=-20;ACHSKREUZWINKEL[7]
_SK_SIGMA[8]=-19;ACHSKREUZWINKEL[8]
_SK_SIGMA[9]=-18.5;ACHSKREUZWINKEL[9]
_SK_SIGMA[10]=-18;ACHSKREUZWINKEL[10]
_SK_SIGMA[11]=-16;ACHSKREUZWINKEL[11]
_SK_LE[0]=0;EINLAUFWEG[0]
_SK_LE[1]=-1.676;EINLAUFWEG[1]
_SK_LE[2]=-1.891;EINLAUFWEG[2]
_SK_LE[3]=-2.04;EINLAUFWEG[3]
_SK_LE[4]=-2.152;EINLAUFWEG[4]
_SK_LE[5]=-2.24;EINLAUFWEG[5]
_SK_LE[6]=-2.312;EINLAUFWEG[6]
_SK_LE[7]=-2.329;EINLAUFWEG[7]
_SK_LE[8]=-2.331;EINLAUFWEG[8]
_SK_LE[9]=-2.351;EINLAUFWEG[9]
_SK_LE[10]=-2.363;EINLAUFWEG[10]
_SK_LE[11]=-2.267;EINLAUFWEG[11]
_SK_LU[0]=0;UEBERLAUFWEG[0]
_SK_LU[1]=0.1;UEBERLAUFWEG[1]
```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AGENDA

- Why SkiveAll?
- Program structure
- New Features in V1.4
- Outlook
- SkiveAll 3D

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Neue Features in Version 1.4

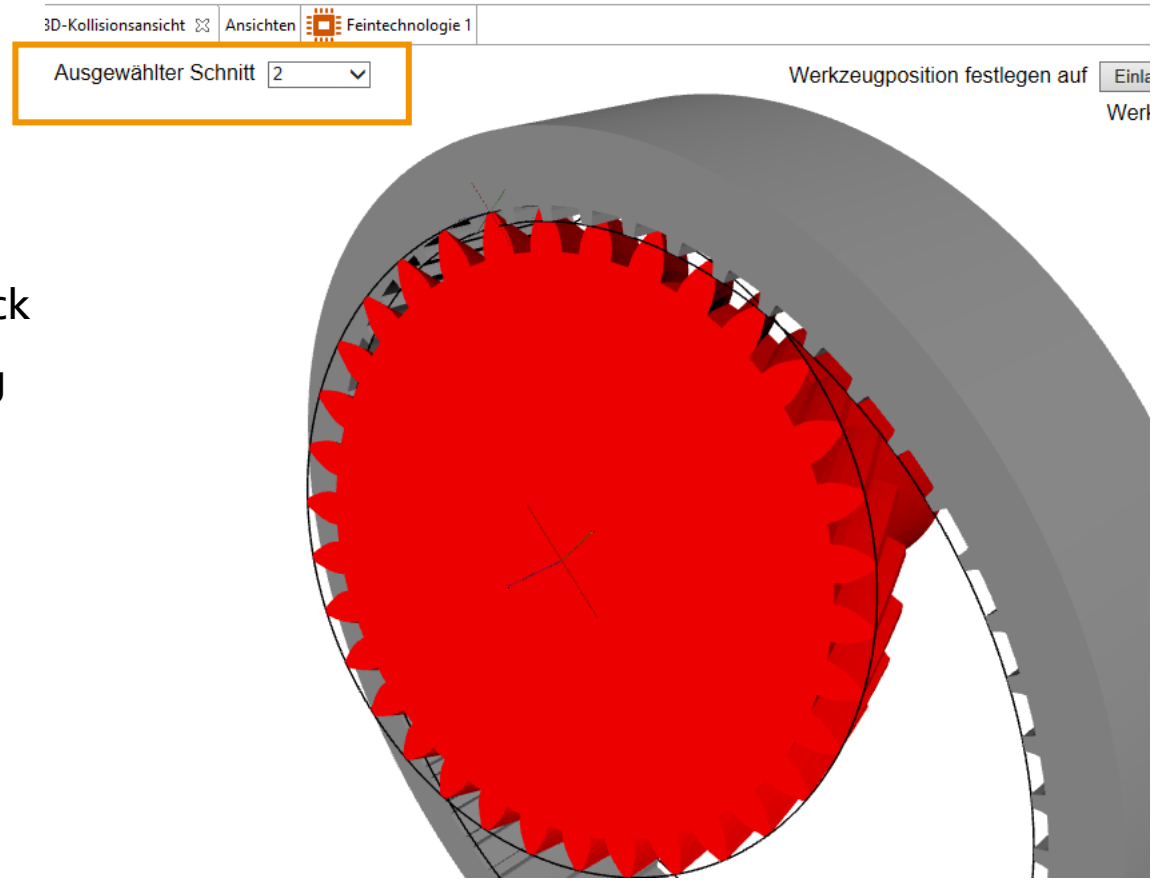
- Separation between roughing and finishing strategies
- 3D Visualization of all cuts
- Optimized tool run-over travel length
- Interfering contour as complex contur
- Improved rake angle calculation

New: Separation between roughing and finishing strategies

- Introduction of a finishing allowance (normal allowance)
- Roughing:
  - Number of cuts freely definable
  - Strategy definable
  - "no roughing" possible
- Finishing:
  - Number of cuts freely definable
  - Strategy definable
  - "no finishing“→ only roughing

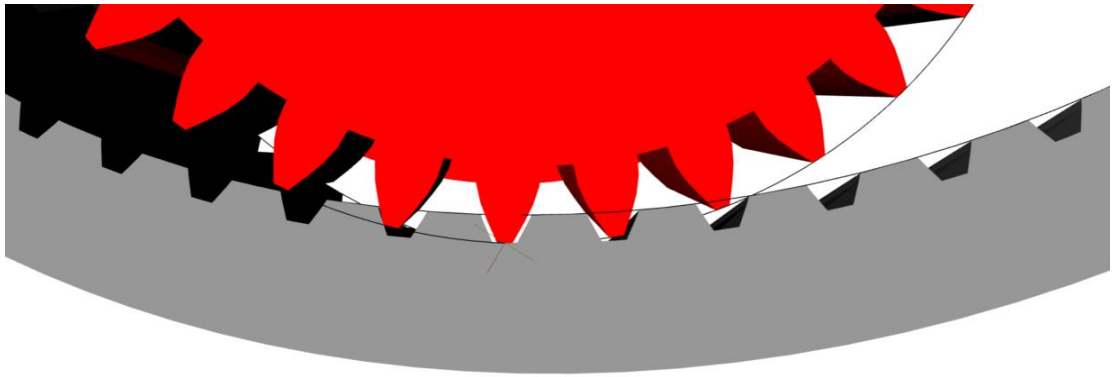
New: 3D visualization of all cuts

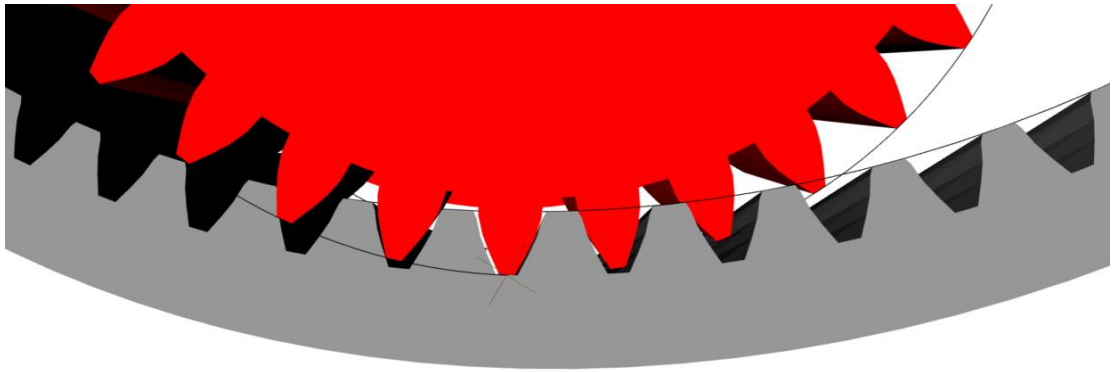
- 3D visualization of all cuts
  - Selection of the respective cut in the 3D collision check
  - Background: collision check for individualized cutting strategies necessary
  - Axis cross angles etc. can vary from cut to cut



New: 3D Visualization of all cuts, more realistic output

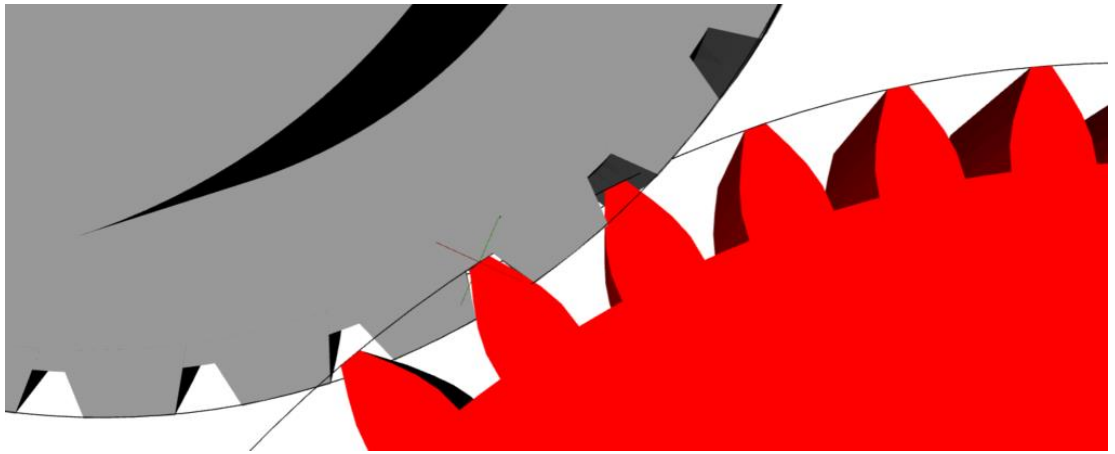
Internal gear, cut 3 / 12

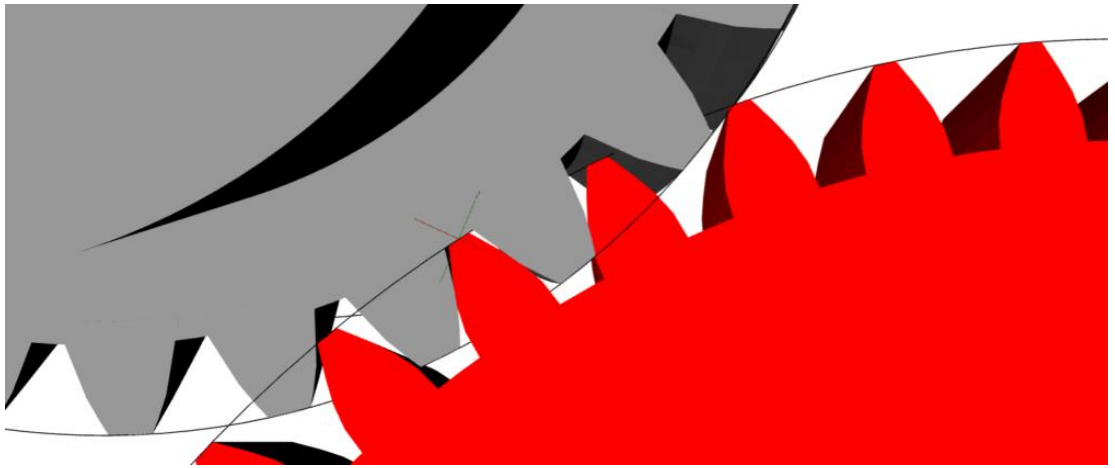




Internal gear, cut 9 / 12

External gear, cut 3 / 9

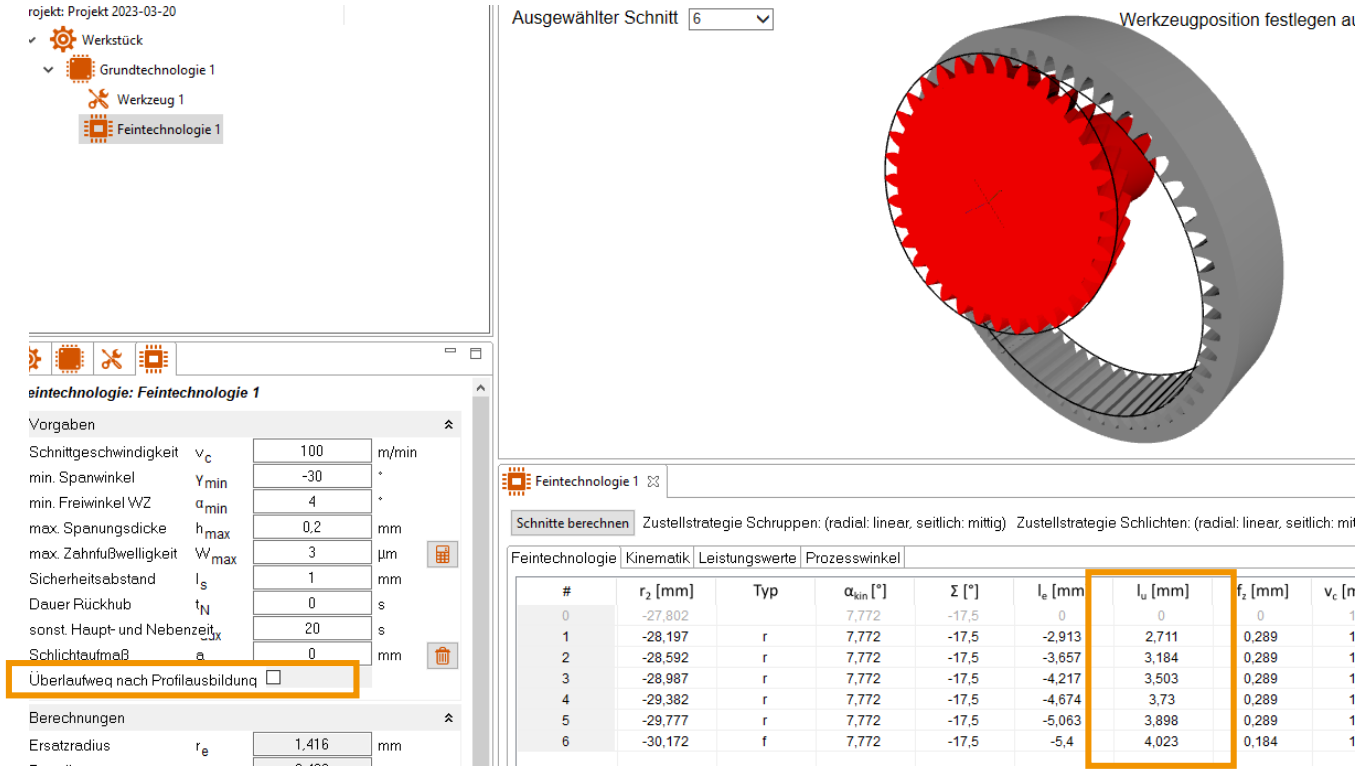




External gear, cut 8 / 9

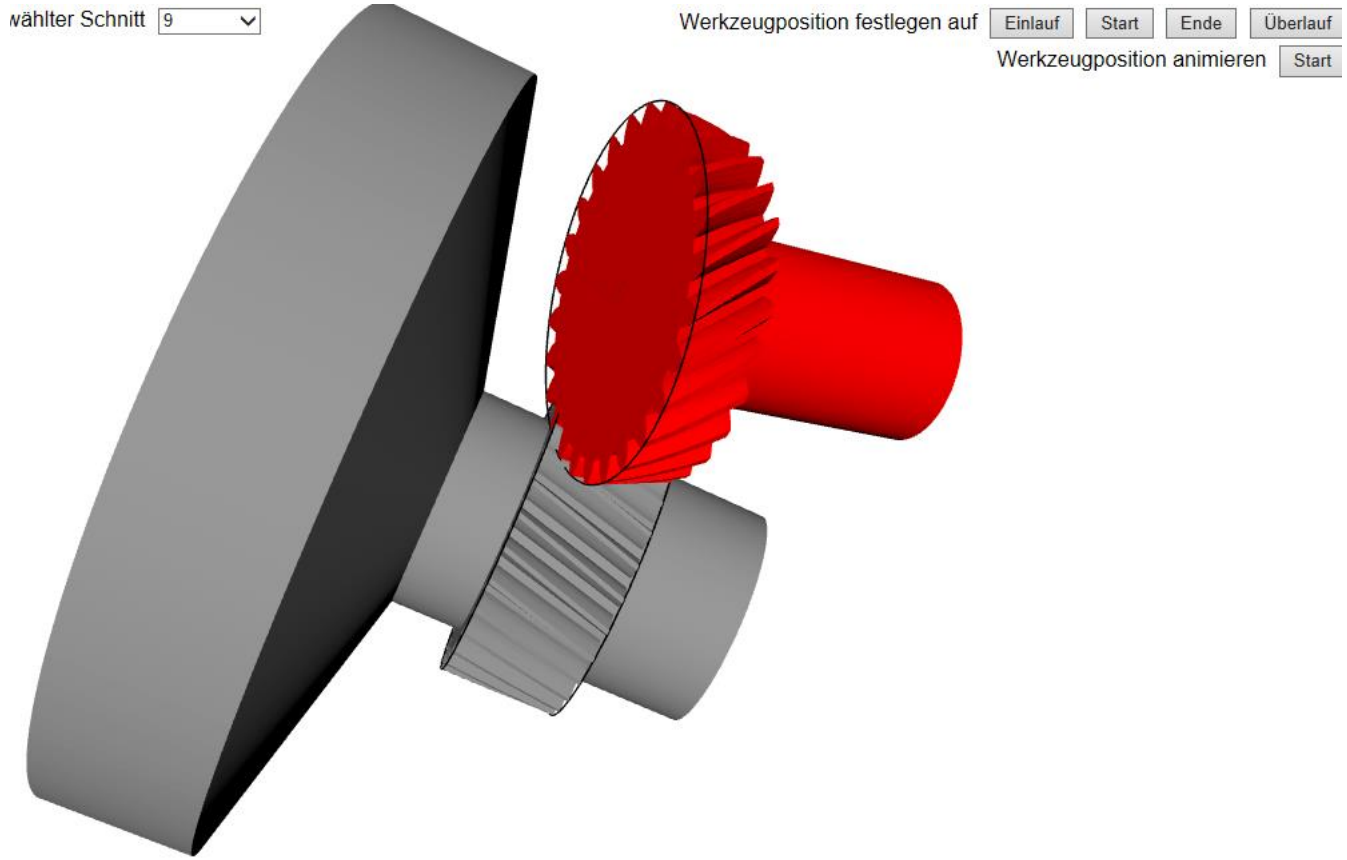
New: Optimized tool run-over travel length

- Tool overflow path is critical with axially adjacent interference contour
- Previously: Calculation of the overflow path after penetration of the tip circles
- New: Calculation of the minimum overflow path after profile formation
- Consequence:
  - Shorter overflow paths
  - Shorter machining times
- Optional selection of tip circles possible



New: Interfering contour as complex contur

- Axial interference contours are decisive for
  - the choice of the axis cross angle
  - Dimensioning of the number of tool teeth
  - Decision cylindrical or conical tool
- Previously: only edge with distance and diameter
- New: definition of a complete contour train



New: Improved rake angle calculation

- Calculation of the rake angle important for determining the cutting strategy.
- Differences in the calculated rake angles between the Basic and 3D modules (exact)
- Conversion of the simplified rake angle calculation in SkiveAll Basic
- Result: improved match

AGENDA

- Why SkiveAll?
- Program structure
- New Features in V1.4
- Outlook
- SkiveAll 3D

Update training for SkiveAll V1.4

- Offer to all existing and interested customers
- Deepening of the new functions
- Repetition of the overall functionality
- Answering of operating questions
- Technology training power skiving

SkiveAll 2.0 – technische Neuerungen

Umsetzung als Webapplikation

- im Browser (Edge, Firefox, Chrome) lauffähig
- keine lokale Installation notwendig
- automatische Aktualisierung auf die jeweils neueste Version

Projektdatenbank

- Verwaltung der Werkstücke und Technologien in einer Datenbank
- verbesserte Suchmöglichkeiten
- vereinfachte Zusammenarbeit

Nutzerdefinierte Formeln

- Anpassung der Berechnungsvorschriften
- Erweiterung des Modells

SkiveAll 2.0 – neue inhaltliche Features

Werkstück-Profilkorrektur	Eingabe Profilfehler Berechnung der Kompensationswerte
Erweiterte Visualisierungsmöglichkeiten	Ausgabewerte der Schnittstrategien Frei konfigurierbare Diagramme
Individuelle Einstellungen	Beispiel: Werkzeug-Rundlauffehler derzeit voreingestellt …
Import- und Exportmöglichkeiten	

AGENDA

- Why SkiveAll?
- Program structure
- New Features in V1.4
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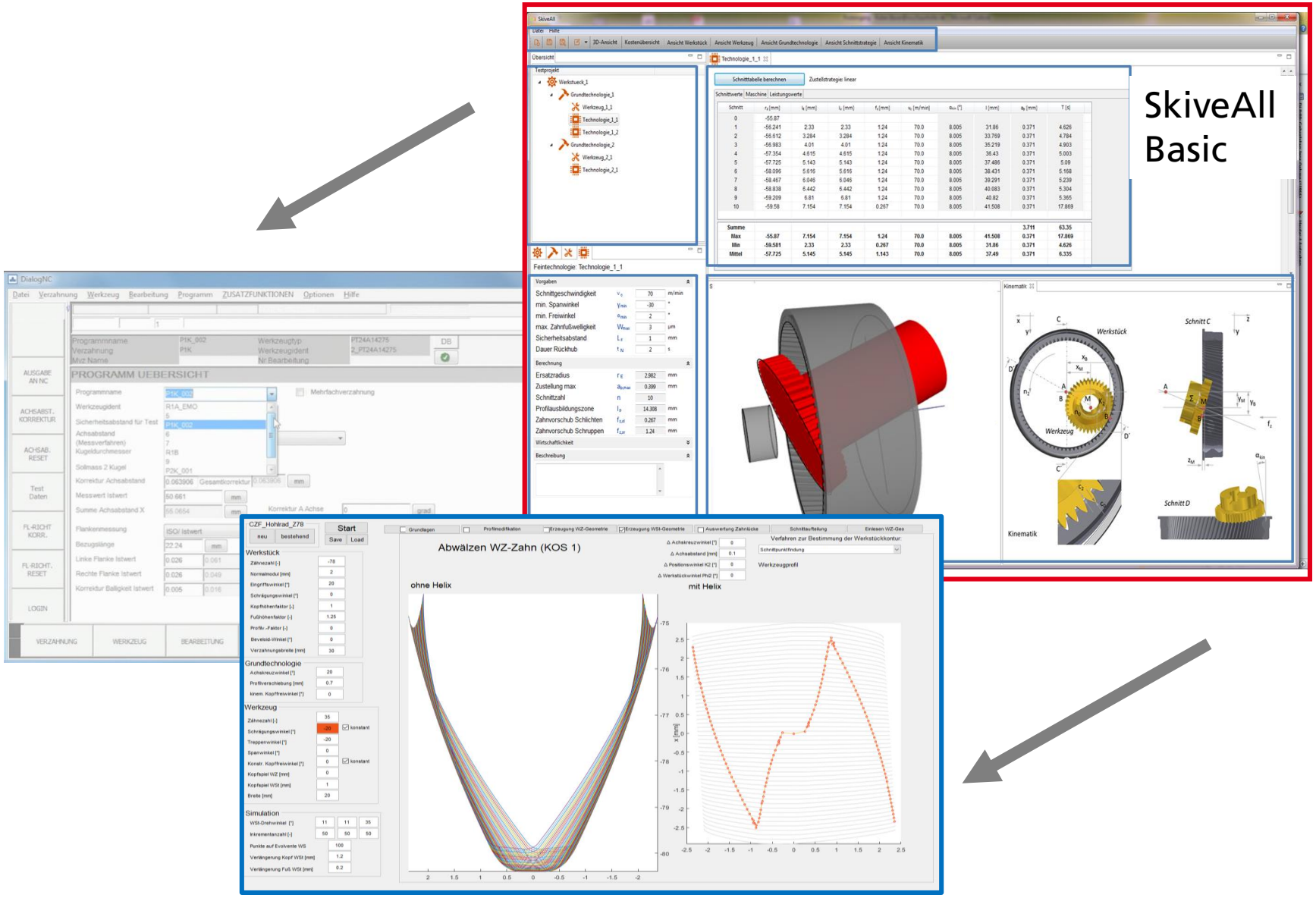
- SkiveAll 3D

SkiveAll 3D

Machine control



SkiveAll 3D

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SkiveAll 3D Features

SkiveAll Basic

Data import

Profile modifications

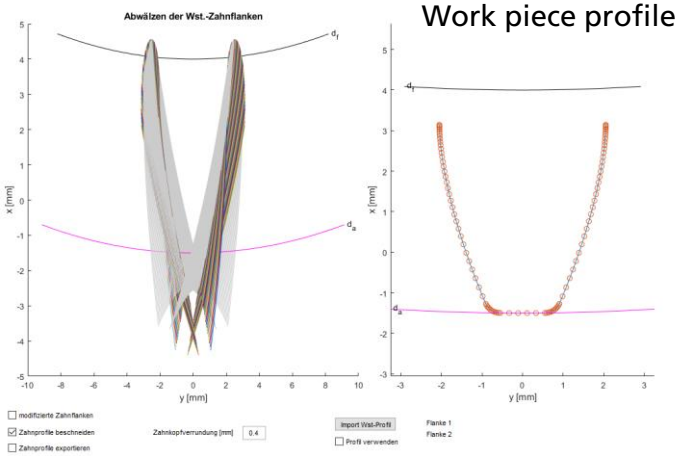
Tool profile calculation

Work piece

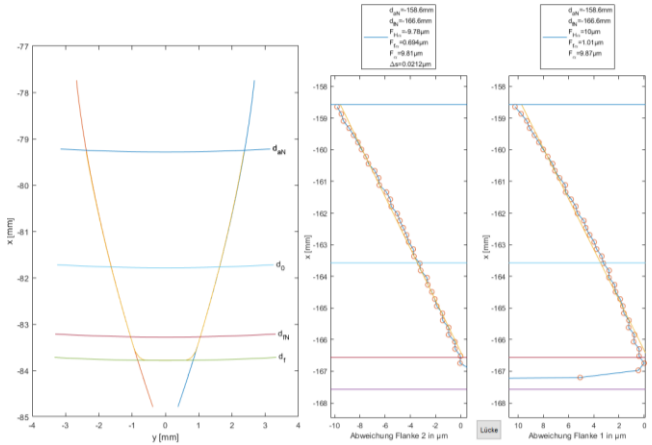
Cutting tool

Process Simulation

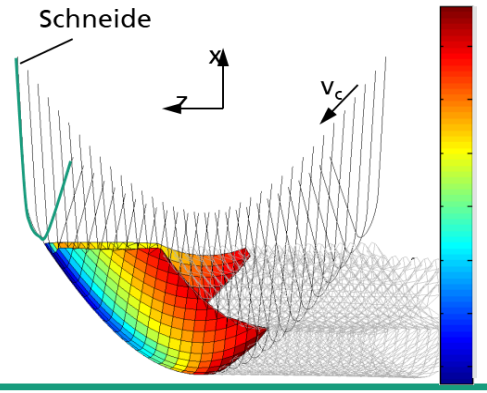
Compensations for profile angle correction

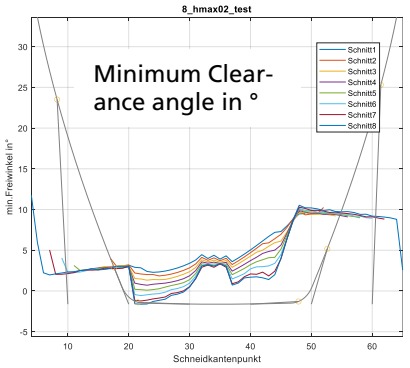


Profil angle deviations



Process vaules simulation





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Thanks for your attention

Ken Wenzel
Marko Friedemann
Ruben Bauer
Alexander Wenzel

- Software **SkiveAll**
  www.skiveall.com

- Webinar SkiveAll V1.4
  29.03.2023 (Englisch)

- Save the date:
  5. Fachseminar Wälzschälen/ Power Skiving
  11/29/2023 in Chemnitz