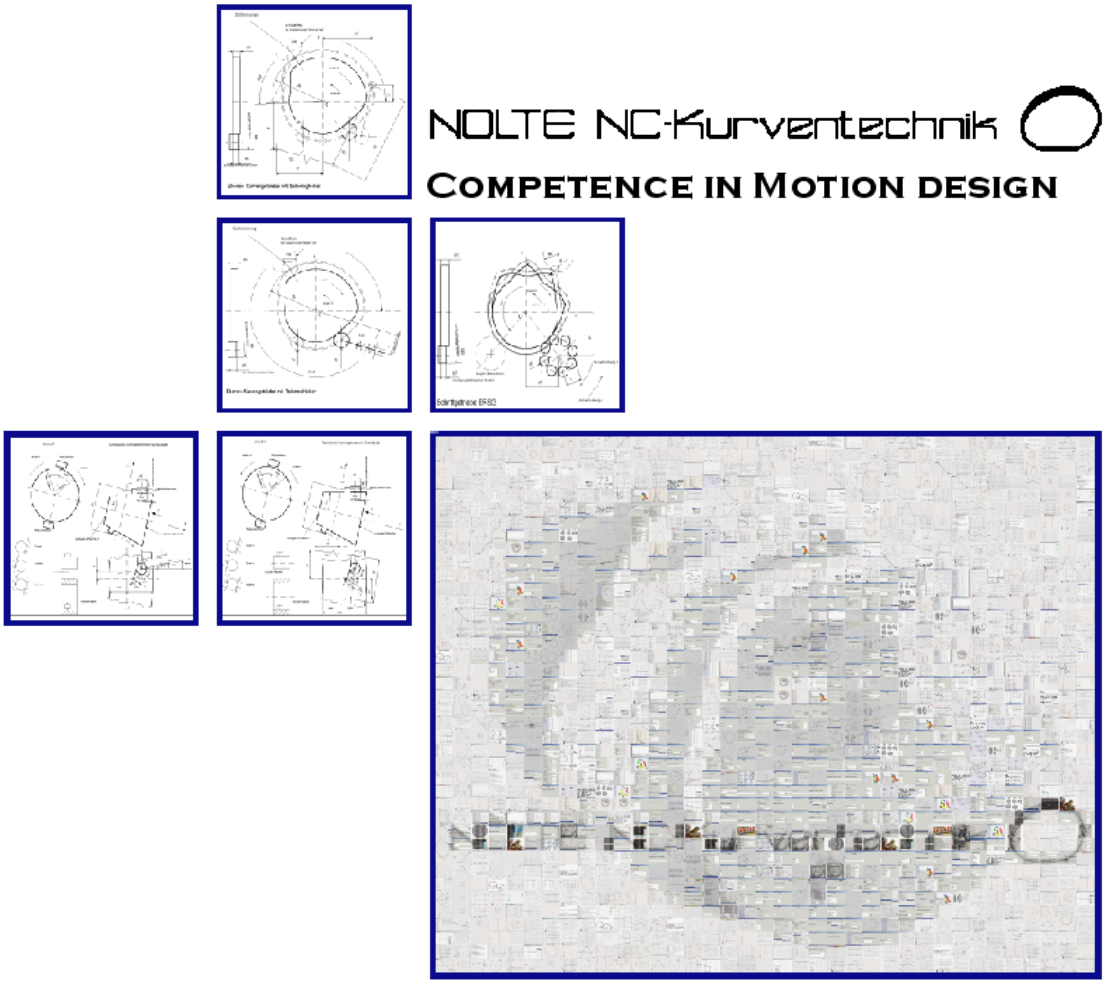
OPTIMUS MOTUS ® Indexing Cams



NOLTE NC-Kurventechnik

COMPETENCE IN MOTION DESIGN

OPTIMUS MOTUS ® Indexing Cams

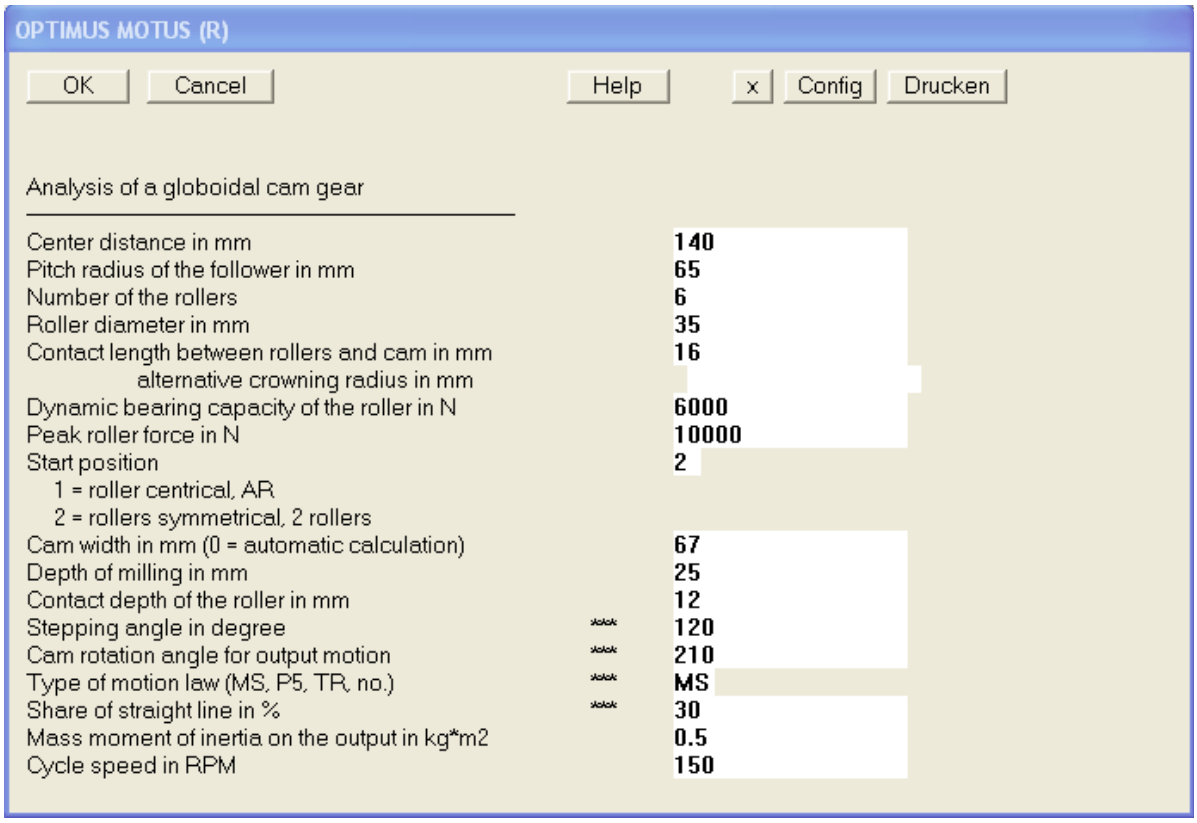
OPTIMUS MOTUS ® can be extended by a module for calculating globoidal, cylindrical, parallel indexing cams and cycloidal cam gears:

- calculation, graphics and tables for the cam contours
- automatic cut-off for contour segments outside the cam part
- neutral and machine-specific NC-programs for milling and grinding
- automatic enhancements for the NC-contours of indexing cams for getting into the contour smoothly and for dealing with tolerances
- automatic concatenation of cam tracks
- automatic narrowing of dwell regions
- calculation of the roller durability with respect to the dynamic load changes
- calculation of the overlap when rollers enter or leave the gearing contact
- calculation of the thickness of the flanges
- diagrams and tables for transmission angle and radius of curvature
- diagrams and tables for the Hertz Pressure
- diagrams and tables for driving torque and power
- calculation of the least possible width respectively diameter of the cam part
- calculation of the minimum required time for constant velocity in the law of motion
- calculation of the maximum possible load on the output shaft of the cam
- calculation of the maximum possible speed of the cam shaft with given loads
- output of all the results summarized on one page

System requirements: Windows XP / Vista / 7 / 8 / 10

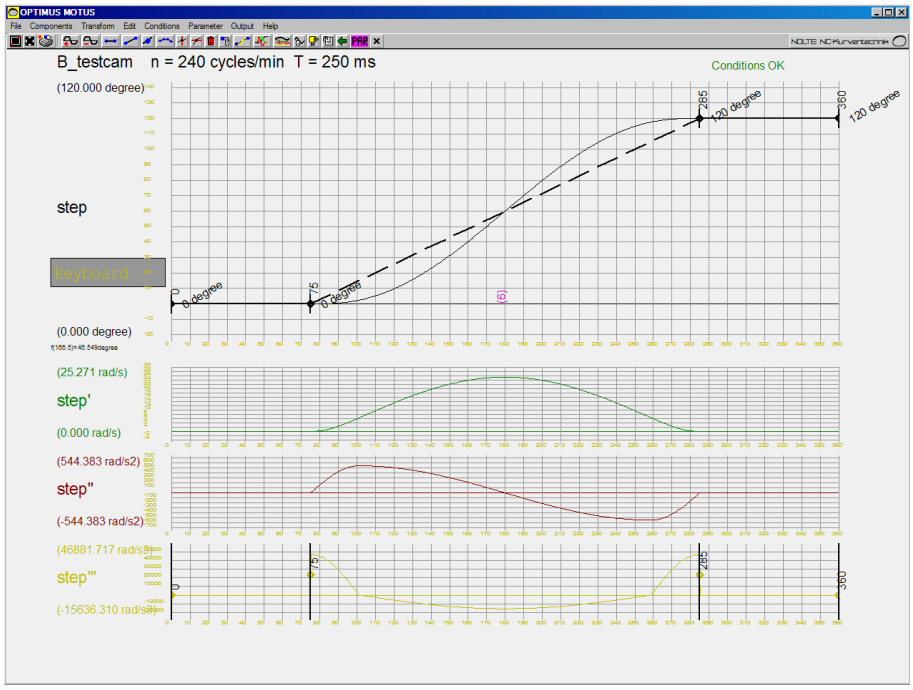
Updated: 13.3.2017

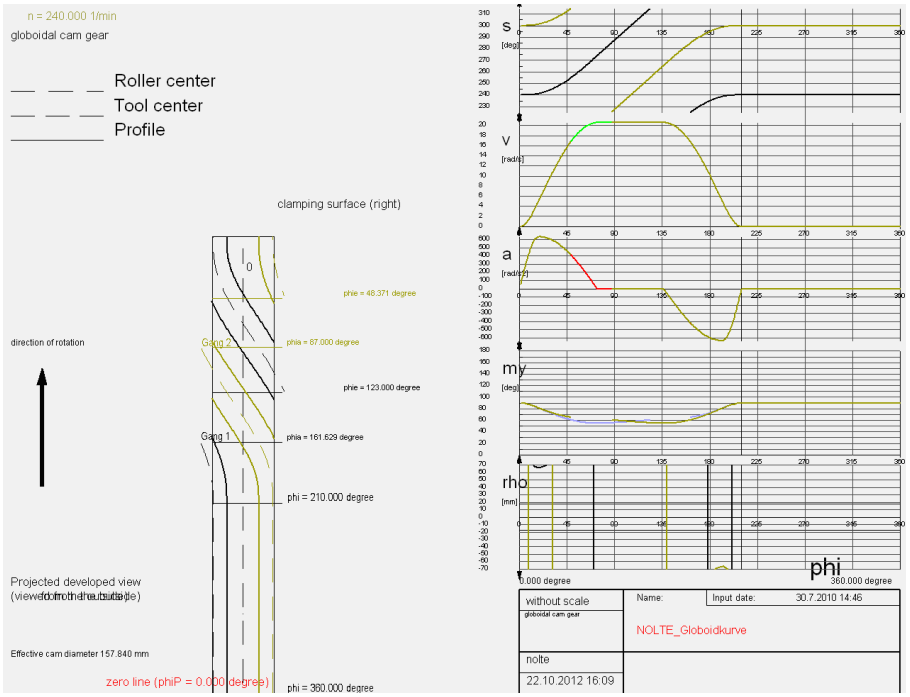
Dialog box for globoidal cams:



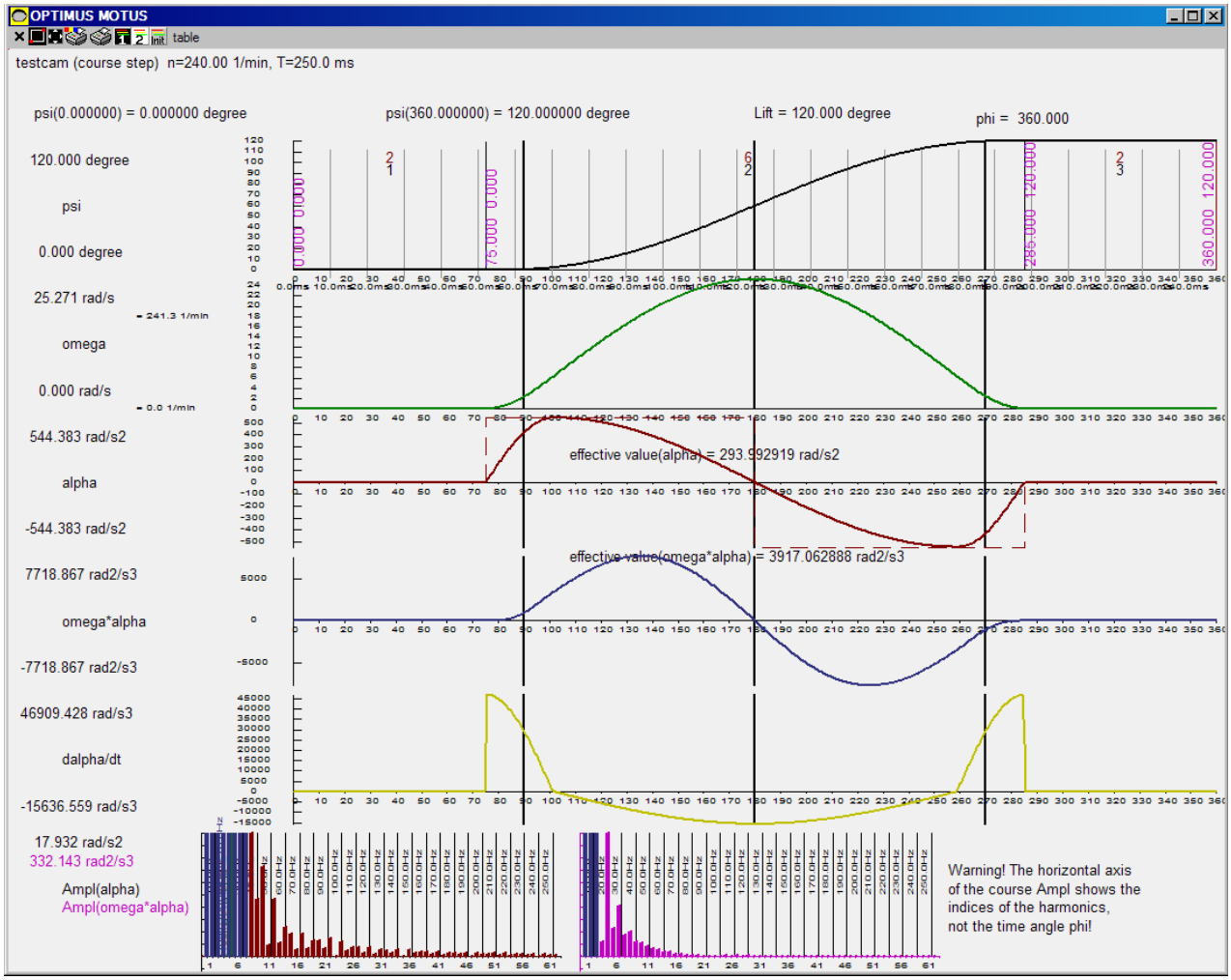
User interface can be switched dynamically between German and English.

Powerful grafical editor for the displacement plan:





Developed view of the cam contours

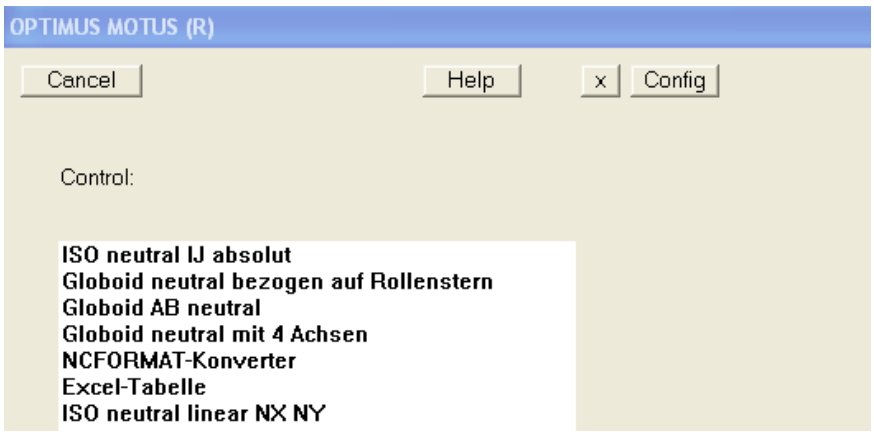


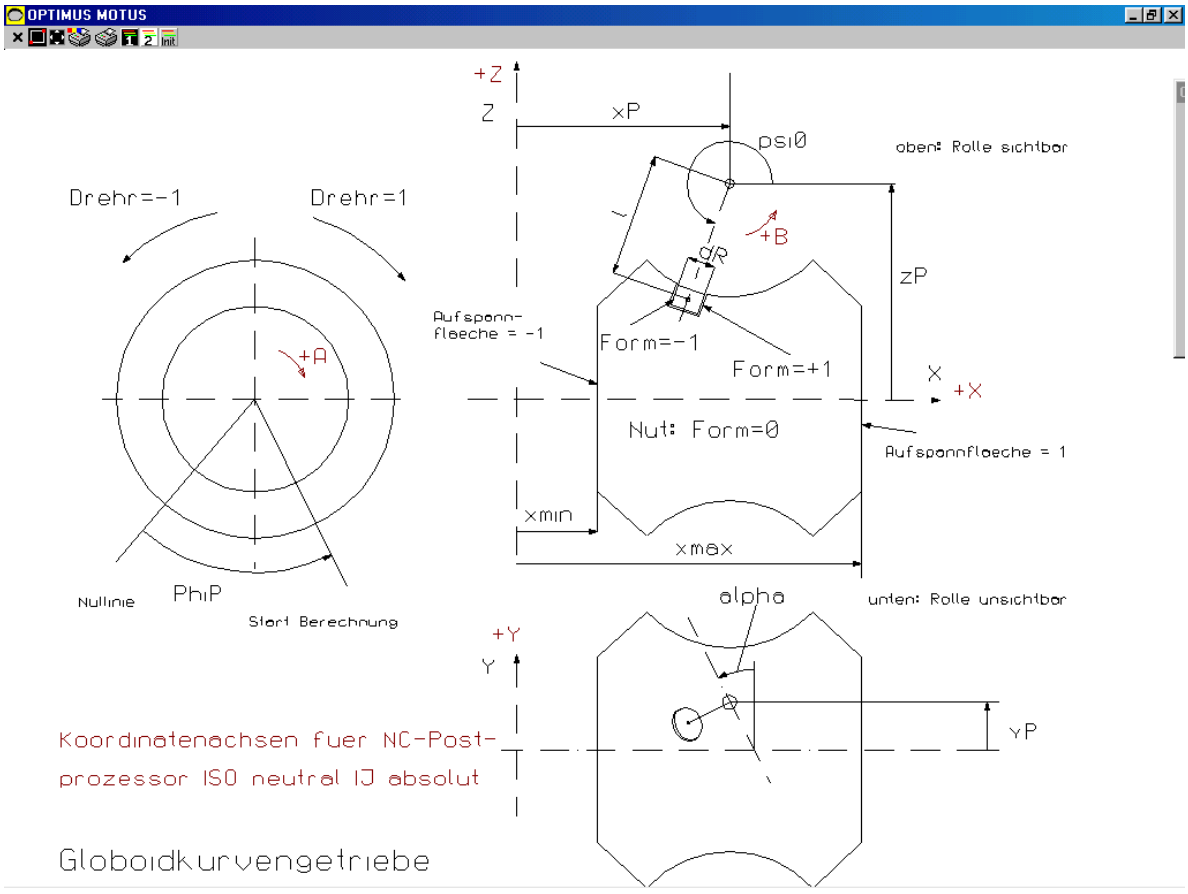
Motion diagram with path, velocity, acceleration, torque, jerk and fourier analysis

Summarized results on one page:

```
Analysis of a globoidal cam gear
--------------------------------------------------------------------------
Center distance in mm                          140
Pitch radius of the follower in mm             65
Number of the rollers                          6
Roller diameter in mm                          35
Contact length between rollers and cam in mm   16
        alternative crowning radius in mm
Dynamic bearing capacity of the roller in N    6000
Peak roller force in N                         10000
Start position                                 2
  1 = roller centrical, AR
  2 = rollers symmetrical, 2 rollers
Cam width in mm (0 = automatic calculation)    67
Depth of milling in mm                         25
Contact depth of the roller in mm              12
Stepping angle in degree                  ***  120
Cam rotation angle for output motion      ***  210
Type of motion law (MS, P5, TR, no.)      ***  MS
Share of straight line in %               ***  30
Mass moment of inertia on the output in kg*m2  0.5
Cycle speed in RPM                             150

One bearing roller

Speed limited by Life time of the roller

Minimum path of overlapping in mm ..............:         0.404
Minimum raised ridge width in mm at the top .....:        14.988
Minimum raised ridge width in mm in the middle ..:        20.376
Minimum raised ridge width in mm at the bottom ..:        22.848
Minimum transmission angle in degree ............:        54.687
Min.radius of curvature on profile in mm, top ...:        76.73
Min.radius of curvature on profile in mm, middle :        53.066
Min.radius of curvature on profile in mm, bottom :        33.726
Maximum force on the rollers in N ..............:      1932.479
Maximum Hertzian surface stress in N/mm2 ........:       496.154
Maximum driving torque in Nm ....................:        56.834
Maximum driving power in kW .....................:         1.116
Nominal roller durability in h (single 90 %) ....:     28356.504
Mod. Roller durability in h (total 90%) .........:      9609.089 (single 98.3%)
Cam flank lifetime for 60 HRC in h ..............:   4697588.817
Cam flank lifetime for 62 HRC in h ..............:   6152654.101
Max. velocity of the output in rad/s ............:        12.863
Max. acceleration of the output in rad/s2 .......:       247.37
----------
Permitted permanent load on the output in Nm ....:        93.567
Max. moment of inertia of the output in kg*m2 ...:         0.731
 corresponding torque on the output in Nm .......:       180.795
Min. width of the cam material in mm ............:        66.9
Min. width by outside dwell-ridges in mm ........:        47.689
Max. permitted cycle speed in RPM ...............:       176.919
Required share of straight line in % ............:         0

    Cam is ok
```

Standard-NC-postprocessors for globoidal cams, based on different coordinate systems





Sample of an NC-program for a globoidal cam

```
ISO neutral IJ absolut:O_NOLTE_Globoidkurve (ACHTUNG! NC-Datei mit Begleitprogramm
NCFORMAT.EXE nachbearbeiten!)
N102G1X-101.860Y0.000Z124.030A171.500B231.041
N104G1X-101.304Y0.000Z123.582A171.826B231.293
N106X-100.748Y0.000Z123.139A172.155B231.545
N108X-100.193Y0.000Z122.700A172.487B231.795
N110X-99.640Y0.000Z122.266A172.822B232.044
N112X-99.087Y0.000Z121.837A173.160B232.291
N114X-98.536Y0.000Z121.413A173.500B232.537
N116X-97.986Y0.000Z120.993A173.844B232.782
N118X-97.439Y0.000Z120.579A174.191B233.025
N120X-96.893Y0.000Z120.170A174.541B233.266
N122X-96.350Y0.000Z119.767A174.895B233.505
N124X-95.809Y0.000Z119.368A175.252B233.743
N126X-95.271Y0.000Z118.976A175.613B233.978
N128X-94.737Y0.000Z118.589A175.977B234.212
N130X-94.205Y0.000Z118.207A176.345B234.443
N132X-93.678Y0.000Z117.832A176.716B234.672
N134X-93.154Y0.000Z117.462A177.092B234.899
N136X-92.635Y0.000Z117.099A177.471B235.123
N138X-92.121Y0.000Z116.742A177.855B235.344
N140X-91.612Y0.000Z116.391A178.243B235.563
N142X-91.108Y0.000Z116.047A178.635B235.778
N144X-90.610Y0.000Z115.710A179.031B235.991
N146X-90.119Y0.000Z115.380A179.432B236.200
N148X-89.634Y0.000Z115.057A179.838B236.406
N150X-89.157Y0.000Z114.741A180.248B236.609
N152X-88.688Y0.000Z114.433A180.663B236.807
N154X-88.227Y0.000Z114.132A181.083B237.002
N156X-87.775Y0.000Z113.840A181.508B237.192
N158X-87.332Y0.000Z113.556A181.938B237.378
N160X-86.900Y0.000Z113.280A182.373B237.560
N162X-86.478Y0.000Z113.013A182.813B237.736
N164X-86.068Y0.000Z112.755A183.258B237.908
N166X-85.670Y0.000Z112.506A183.708B238.074
N168X-85.285Y0.000Z112.267A184.164B238.234
N170X-84.914Y0.000Z112.037A184.625B238.388
N172X-84.557Y0.000Z111.818A185.091B238.537
N174X-84.214Y0.000Z111.609A185.562B238.678
N176X-83.888Y0.000Z111.411A186.038B238.813
N178X-83.578Y0.000Z111.224A186.520B238.941
N180X-83.286Y0.000Z111.049A187.006B239.062
N182X-83.011Y0.000Z110.885A187.497B239.175
N184X-82.755Y0.000Z110.732A187.993B239.281
N186X-82.518Y0.000Z110.591A188.492B239.378
N188X-82.300Y0.000Z110.462A188.996B239.468
N190X-82.100Y0.000Z110.345A189.503B239.550
N192X-81.920Y0.000Z110.239A190.014B239.623
N194X-81.759Y0.000Z110.145A190.528B239.690
N196X-81.616Y0.000Z110.061A191.044B239.748
N198X-81.491Y0.000Z109.989A191.562B239.799
N200X-81.384Y0.000Z109.926A192.083B239.843
N202X-81.292Y0.000Z109.873A192.605B239.881
```

...

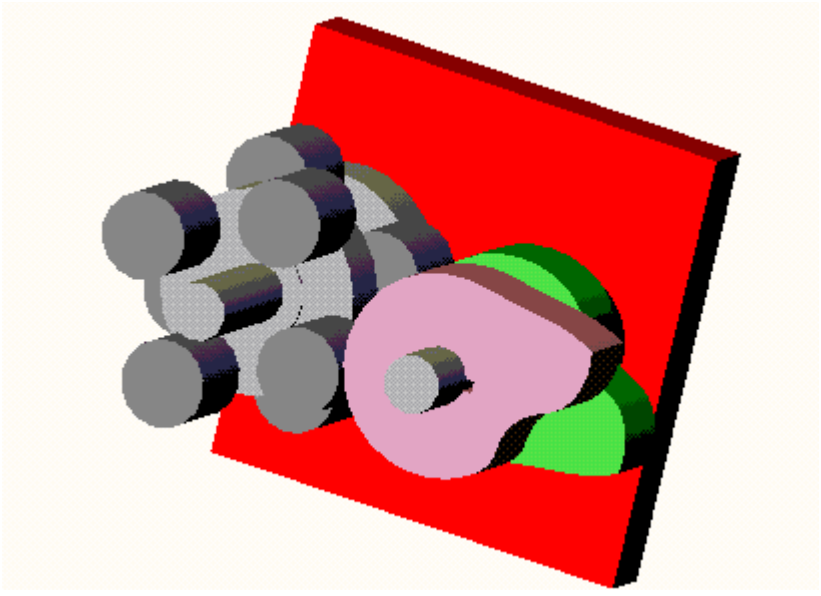
Dialog box for a planar parallel cam gear:

OPTIMUS MOTUS (R)

OK | Cancel | Help | x | Config | Drucken

Analysis of a parallel cam gear

Center distance in mm		80
Pitch radius of the follower in mm		40
Number of the rollers		6
Roller diameter in mm		22
Contact length between rollers and cam in mm		
alternative crowning radius in mm		500
Dynamic bearing capacity of the roller in N		5000
Peak roller force in N		6000
Diameter of the cam in mm		110
Thickness of the cam in mm		15
Stepping angle in degree	***	120
Cam rotation angle for output motion	***	300
Type of motion law (MS, P5, TR, no.)	***	MS
Share of straight line in %	***	30
Mass moment of inertia (output shaft), kg*m2:		1
Cycle speed in RPM		100



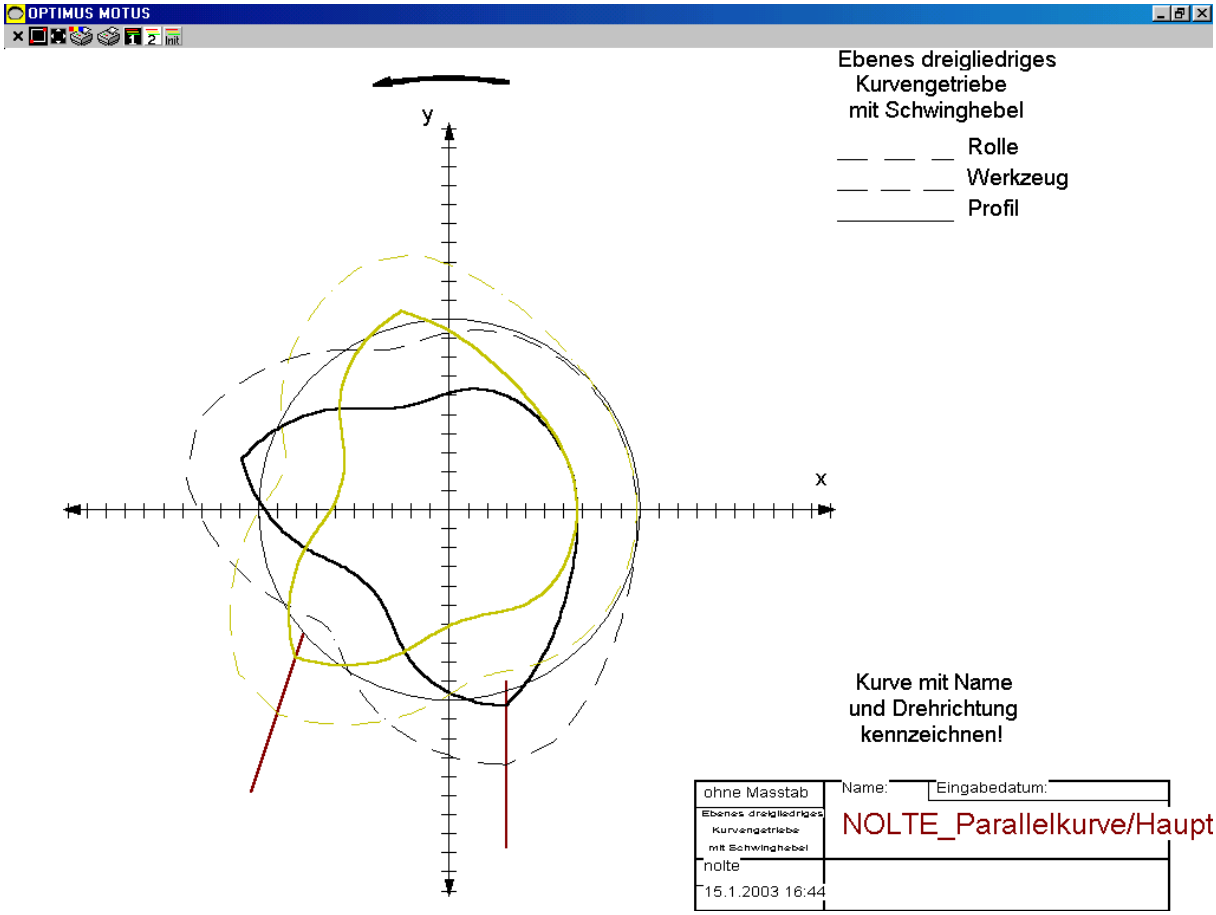


Image of the parallel cams

Summarized results on one page:

```
Analysis of a parallel cam gear
------------------------------------------------------------------------
Center distance in mm                          80
Pitch radius of the follower in mm             40
Number of the rollers                          6
Roller diameter in mm                          22
Contact length between rollers and cam in mm
        alternative crowning radius in mm       500
Dynamic bearing capacity of the roller in N    5000
Peak roller force in N                         6000
Diameter of the cam in mm                      110
Thickness of the cam in mm                     15
Stepping angle in degree                  ***  120
Cam rotation angle for output motion      ***  300
Type of motion law (MS, P5, TR, no.)     ***   MS
Share of straight line in %               ***  30
Mass moment of inertia (output shaft), kg*m2: 1
Cycle speed in RPM                             100

FOLLOWER IS NOT GUIDED FOR THE WHOLE TIME!
 --> Overlapping path cannot be calculated
TRANSMISSION ANGLE TOO SMALL!

Speed limited by Hertzian surface stress

Minimum path of overlapping in mm ...............: not available
Minimum transmission angle in degree ............:         1.158
Min. radius of curvature on the profile in mm ...:        21.782
Maximum force on the rollers in N ...............:      1537.606
Maximum Hertzian surface stress in N/mm2 ........:      1301.551
Maximum driving torque in Nm ....................:        17.328
Maximum driving power in kW .....................:         0.227
Nominal roller durability in h (single 90 %) ....:     73468.003
Mod. Roller durability in h (total 90%) .........:     37182.415 (single 96.5%)
Cam flank lifetime for 60 HRC in h ..............:     22067.341
Cam flank lifetime for 62 HRC in h ..............:     28387.36
Max. velocity of the output in rad/s ............:         6.003
Max. acceleration of the output in rad/s2 .......:        53.874
----------
Permitted permanent load on the output in Nm ....:        36.295
Max. moment of inertia of the output in kg*m2 ...:         1.328
 corresponding torque on the output in Nm .......:        71.555
Min. diameter of the cam in mm ........: not available
Max. permitted cycle speed in RPM ...............:       115.247
Max. permitted radius of the follower in mm .:        50.971
Required share of straight line in % ............:         0

    Please check the cam design!
```

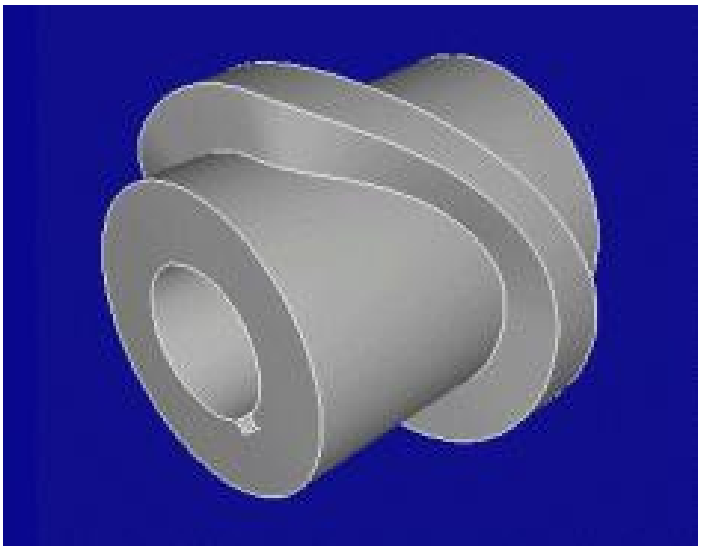
Dialog box for cylindrical indexing cams:

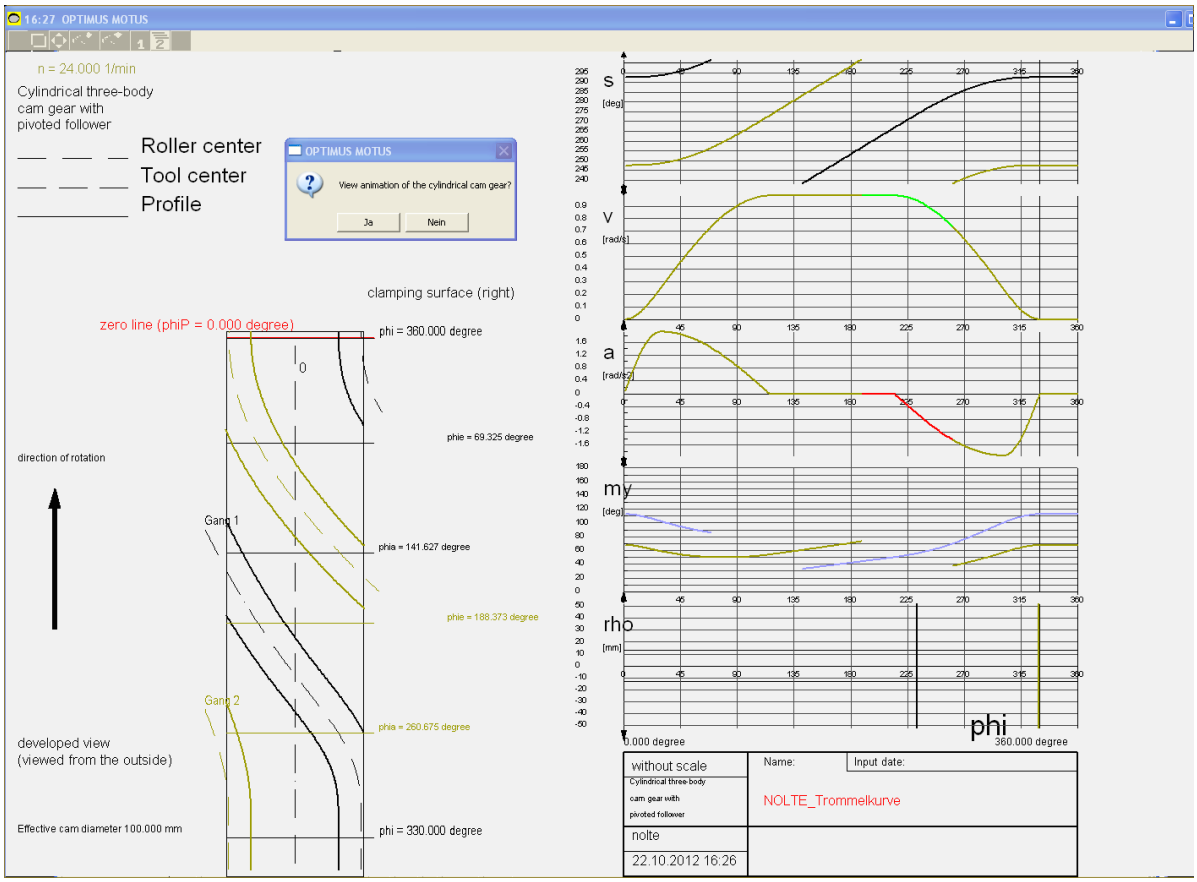
OPTIMUS MOTUS (R)

OK | Cancel | Help | x | Config | Drucken

Analysis of a cylindrical cam gear

Center distance in mm		100
Pitch radius of the follower in mm		100
Number of the rollers		8
Roller diameter in mm		26
Contact length between rollers and cam in mm		10
alternative crowning radius in mm		
Dynamic bearing capacity of the roller in N		6000
Peak roller force in N		7000
Start position		2
1 = roller centrical, AR		
2 = rollers symmetrical, 2 rollers		
Pitch diameter of the cam cylinder in mm		100
Cam width in mm (0 = automatic calculation)		0
Depth of milling in mm		20
Contact depth of the roller in mm		10
Stepping angle in degree	***	90
Cam rotation angle for output motion	***	330
Type of motion law (MS, P5, TR, no.)	***	MS
Share of straight line in %	***	30
Mass moment of inertia on the output in kg*m2		0.11
Cycle speed in RPM		24





Developed view for cylindrical indexing cams plus animation

Summarized results on one page:

```
Analysis of a cylindrical cam gear
------------------------------------------------------------------------
Center distance in mm                          100
Pitch radius of the follower in mm             100
Number of the rollers                          8
Roller diameter in mm                          26
Contact length between rollers and cam in mm   10
        alternative crowning radius in mm
Dynamic bearing capacity of the roller in N    6000
Peak roller force in N                         7000
Start position                                 2
  1 = roller centrical, AR
  2 = rollers symmetrical, 2 rollers
Pitch diameter of the cam cylinder in mm       100
Cam width in mm (0 = automatic calculation)    78.9
Depth of milling in mm                         20
Contact depth of the roller in mm              10
Stepping angle in degree                  ***  90
Cam rotation angle for output motion      ***  330
Type of motion law (MS, P5, TR, no.)      ***  MS
Share of straight line in %               ***  30
Mass moment of inertia on the output in kg*m2  0.11
Cycle speed in RPM                             24

One bearing roller

TRANSMISSION ANGLE TOO SMALL!

Speed limited by Life time of the roller

Minimum path of overlapping in mm ..............:         0.38
Minimum raised ridge width in mm at the top .....:        28.853
Minimum raised ridge width in mm in the middle ..:        23.947
Minimum raised ridge width in mm at the bottom ..:        20.743
Minimum transmission angle in degree ............:        35.57
Min.radius of curvature on profile in mm, top ...:        78.461
Min.radius of curvature on profile in mm, middle :        59.483
Min.radius of curvature on profile in mm, bottom :        35.772
Maximum force on the rollers in N ...............:         2.736
Maximum Hertzian surface stress in N/mm2 ........:        27.19
Maximum driving torque in Nm ....................:         0.046
Maximum driving power in kW .....................:         0
Nominal roller durability in h (single 90 %) ....:         6.52e+014
Mod. Roller durability in h (total 90%) .........:         1.87e+014 (single 98.7%)
Cam flank lifetime for 60 HRC in h ..............:         1.09e+015
Cam flank lifetime for 62 HRC in h  .............:         1.43e+015
Max. velocity of the output in rad/s ............:         0.982
Max. acceleration of the output in rad/s2 .......:         1.924
----------
Permitted permanent load on the output in Nm ....:       257.048
Max. moment of inertia of the output in kg*m2 ...:       206.417
 corresponding torque on the output in Nm .......:       397.073
Min. width of the cam material in mm ............:        78.9
Min. width by outside dwell-ridges in mm ........:        50.537
Max. permitted cycle speed in RPM ...............:       635.928
Min. diameter of the cam cylinder ...............:       213.547
Required share of straight line in % ............:       100

    Please check the cam design!
```

Available Laws of motion in OPTIMUS MOTUS ®:

1 Linear dwell
2 Circular dwell
3 Cycloidal motion
4 Polynomial 5th order
5 Modified trapezoidal
6 Modified sine
7 Simple sine
8 General cycloidal motion
9 Harmonic motion law
10 Polynomial 5th order with straight line
11 Polynomial 11th order
12 Squared parabola
13 Modified sine G-G
14 Sine-straight line-combination U-U
15 Modified trapezoidal R-U
16 Harmonic combination R-U
17 Harmonic combination G-U
18 Polynomial 5th order B-B
19 Straight line
20 Modified trapezoidal U-U
21 Spline1
22 Cubic splines
23 Acceleration polygon type A
24 Modified harmonic combination type A
25 Modified harmonic combination type B
26 Trigonometric cos-splines
27 Law M1
28 Polynomial 8^{th} order
29 Acceleration polygon general
30 Low-noise cosine combination
31 Polynomial 3^{rd} order
32 Polynomial 4^{th} order
33 Polynomial 6^{th} order
34 Polynomial 7^{th} order
35 Polynomial max. 20th order with coefficients
36 Polynomial max. 20th order with conditions
37 Table of values
38 Reflected sine
39 Fourier series
40 Constant value 1
41 Modifizied sine with inserted straight line R-R
42 Synchronous operation
43 Modifizied harmonic combination type C
44 Modifizied harmonic combination type D
45 List of dwell-to-dwell-transitions
46 General Sine Combination
47 Double Harmonic
48 Energy saving Polynomial 1
49 Energie saving Polynomial 2
50 Polynomial 15^{th} order
51 Freudenstein 1-3
52 Gutman F-3
53 Berzak D
54 Berzak E
55 Peisekah 11^{th} degree
56 Polynomial Spline
57 Polynomial 7^{th} degree A
58 Polynomial 13^{th} degree
59 HS motion law RR
60 YMS-3
61 YCMV-3
62 YHP-5

Names of Motion Laws may differ regionally!