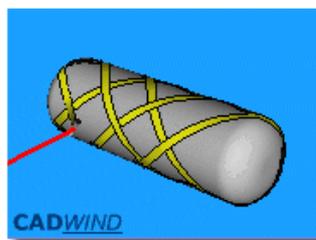


CADWIND

PROCESS SIMULATION SOFTWARE FOR FILAMENT WINDING TECHNOLOGY

CADWIND is the world's most sophisticated process simulation software for the filament winding of composite materials. CADWIND simulates the process using a computer generated model of the winding. It calculates the winding pattern for any mandrel geometry and automatically generates the part program to produce the part on virtually any winding machine.



Simulation



```
% N SP MPF
;SPATH=/ N MPF DIR
N10 G91 C18.00 Z31.38 F16380.
N20 C6.51 Z11.34 F9298.6
N30 C4.55 Z21.68 X7.22 A-1.76
N40 C2.03 Z2.78 X1.45 A-0.33
N50 C4.43 Z3.63 X2.17 A-1.85
N60 C7.19 Z4.73 X3.19 A-2.95
N70 C5.21 Z2.57 X2.03 A-1.88
N80 C5.09 Z1.55 X1.23 A-2.06
N90 C4.87 Z0.59 X0.52 A-2.26
N100 C9.01 Z-0.08 X-0.07 A-3.1
N110 C4.36 Z-0.59 X-0.52 A-1.1
```

Resulting Part Program

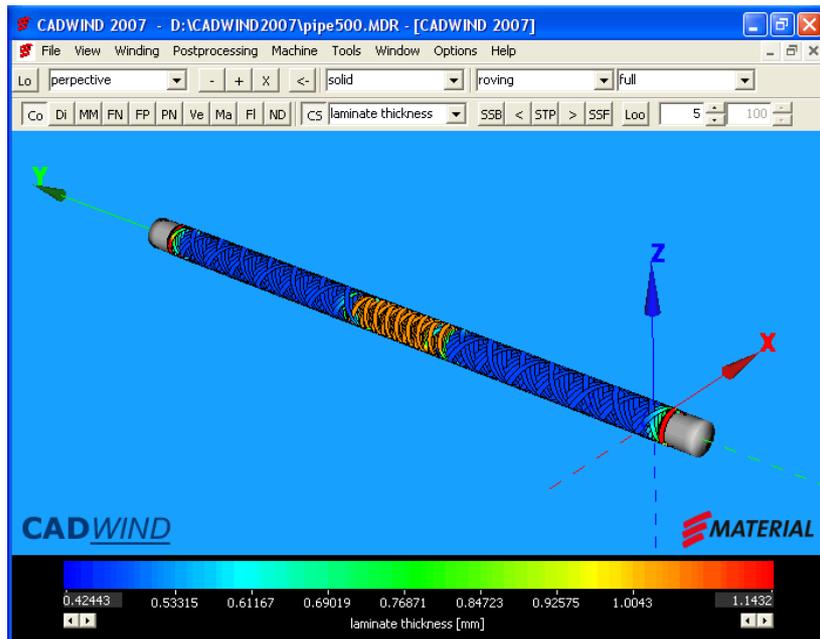
FEATURES

Physical modelling

The most important feature of CADWIND is the physical modelling of the winding process. This unique simulation concept, proven over more than 20 years, is much more powerful than the usual analytical geometrical formulas.

Friction modeling

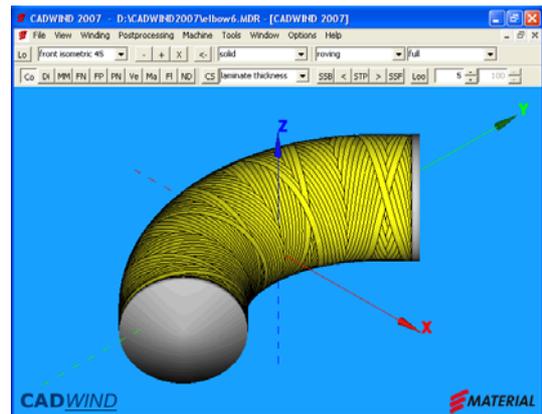
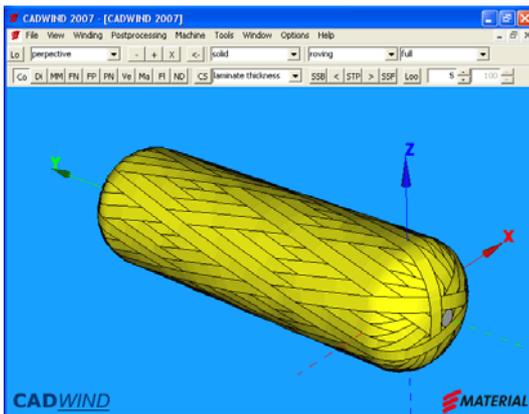
CADWIND's simulation concept includes the modelling of the friction between the fibre and the mandrel. This friction allows it to deviate from the geodesic path (i.e. the shortest distance between two points on a curved surface) and thus gives much wider range of design and production possibilities. This feature differentiates CADWIND from many other filament winding software packages on the market.



CADWIND's friction modelling allows variation in the winding angle. The middle section of the above winding has a higher winding angle, which results in a thicker laminate. CADWIND makes this easily visible using a colour scale.

Axisymmetric and non-axisymmetric geometries

The simulation method allows CADWIND to calculate the fibre lay-up for any part geometry: for simple axisymmetric geometries like tubes to complex non-axisymmetric geometries like elbows and T fittings.



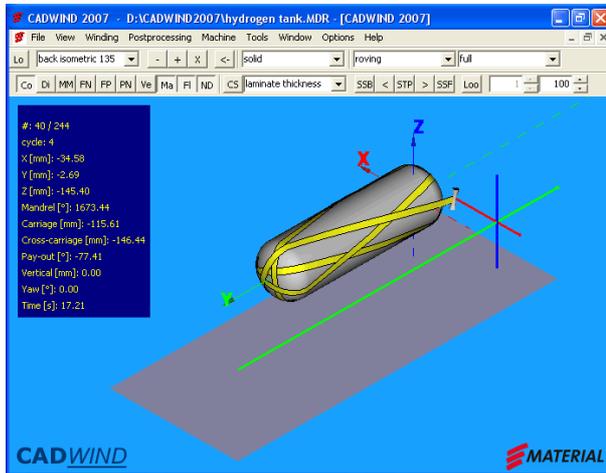
An example of an axisymmetric pressure vessel and a non-axisymmetric pipe elbow

Any machine or robot

CADWIND generates the part program for almost any type of machine and controller, no matter if it is a simple 2 axis machine, a complex 6 axis winder, a specialised T-winder or a robot, CADWIND's part programs run on every possible machine.

Real-time machine simulation

CADWIND allows you to fully visualise the winding process. It shows you a dynamic, real-time animation of the machine actually winding the fibres. This gives you a much better impression of what to expect when the winding program is taken to the machine. You can see the machine movements and their dynamics, if the winding program runs smoothly, if the range of an axis is exceeded, or if the pay-out eye will collide with the mandrel, before it happens.

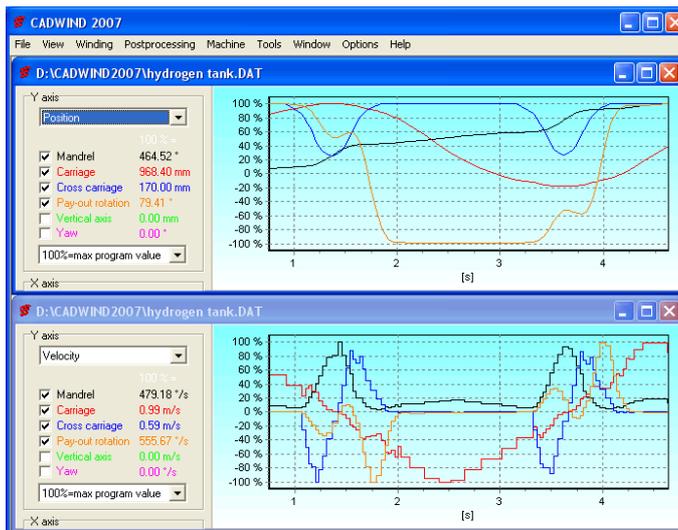


The machine simulation shows the different machine axes, the workshop floor and displays the positions of the machine axes numerically.

Optimal machine dynamics

CADWIND gives full control over the dynamics of the machine movement. This allows the optimisation of your control data according to different criteria like

- optimisation of production time,
- winding with the mandrel rotating at constant speed or
- using a constant pay-out speed.



You can analyse the winding machine dynamics using displacement-time, speed-time and acceleration-time diagrams.

Design and analysis

For the prediction and analysis of the mechanical properties of the filament wound parts CADWIND fully integrates with any finite element analysis (FEA) program. The FEA interface allows you to export all the necessary data (part geometry, laminate structure, stacking sequence, fibre orientation, thickness) from all points of the part to any FEA program. CADWIND's "Design Pack" also includes the COMPOSITE STAR laminate analysis software.

Solid modeling

For thick walled parts with many layers, solid modelling is needed. CADWIND allows you to easily wind thick walled parts by considering the thickness build-up of each layer.

Variation of the winding angle

The friction modelling ability allows the winding angle to be varied in different regions of the part. A good example for the use of this feature is masts for wind-surfers. Using different winding angles, the rigidity can be varied along the mast.

Layer linking

CADWIND can link different layers (e.g. a pressure vessel with a low angle helical winding and a circumferential winding) so that the part can be wound without stopping the machine. This can reduce production time considerably on parts with more than one winding sequence (eg. if a combination of helical and hoop layers are used).

Automation

The machine simulation as well as the flexibility of CADWIND allows the system to adapt to a high degree of automation. For example, special commands for the automated attachment and cutting of the filaments can be easily integrated into the winding program. MATERIAL works closely with all machine manufactures to improve integration and automation. The special needs of the end-user are always take into consideration and, if technically possible, included in the software.

User interface

CADWIND has many features to give the user more information about the winding process. There is a colour scale, which indicates the winding angle, the laminate thickness or the geodesic behaviour at any point of the winding by colouring the laminate. Another handy tool is the graphical display of the displacement-time, velocity-time and acceleration-time diagrams of the machine movement. An important objective has not been forgotten: to keep things simple. CADWIND has always been known as having a simple and stable user interface.

System requirements

CADWIND runs on any computer with Windows 98SE, ME, NT, 2000, XP or VISTA.

VERSIONS & OPTIONS

There are four CADWIND packages: ESSENTIAL, STANDARD, EXPERT and HIGH-END. Any of these packages can be extended with the DESIGN PACK option. The following table compares the capabilities of the different packages.

Axisymmetric part geometries	essential	standard	expert	high-end
cylinder, tube with circular cross-section	x	x	x	x
vessel, bottle, cone		x	x	x
any axisymmetric geometry			x	x

Non-axisymmetric part geometries	essential	standard	expert	high-end
tube with rectangular, elliptical or any other cross-section			x	x
elbow with circular, rectangular, elliptical or any other cross-section				x
T-part				x
any non-axisymmetric geometry				x

Mandrel model generator	essential	standard	expert	high-end
cylinder, tube with circular cross-section	x	x	x	x
vessel, bottle, cone		x	x	x
tube with rectangular or elliptical cross-section			x	x
elbow with circular, rectangular or elliptical cross-section				x
T-part				x

Mandrel model import and export	essential	standard	expert	high-end
import via DXF	x	x	x	x
export via CADWIND contour or surface data file	x	x	x	x

Laminate calculation	essential	standard	expert	high-end
physical modeling and friction modeling	x	x	x	x
geodesic and non-geodesic winding	x	x	x	x
variable winding angle	x	x	x	x
variable friction definition	x	x	x	x
color scale indication of the winding angle, laminate thickness, geodesic behavior and fiber bridging	x	x	x	x
analytical circumferential winding	x	x	x	x
analytical helical winding	x	x	x	x
analytical polar winding		x	x	x
solid modeling, thickness build-up calculation		x	x	x
layer linking		x	x	x
T-part				x

Calculation of the machine motion	essential	standard	expert	high-end
consideration of the machine's maximum velocities and accelerations	x	x	x	x
minimal production time	x	x	x	x
constant mandrel speed	x	x	x	x
constant pay-out speed	x	x	x	x
calculation of the winding time and fiber consumption	x	x	x	x
display of the displacement-time, speed-time and acceleration-time diagrams	x	x	x	x
fiber path editing			x	x

Calculation of the part program for the winding machine	essential	standard	expert	high-end
2 to 6 axes winding machines	x	x	x	x
robots	x	x	x	x
specialized or custom build winding machines	x	x	x	x
output for any machine control system	x	x	x	x
output in a user defined format	x	x	x	x
output in CADWIND's controller independent format	x	x	x	x
special part program commands for automation	x	x	x	x
control data editing and translation to any part program format			x	x

Machine simulation	essential	standard	expert	high-end
real-time visualization of the moving machine	x	x	x	x
visualization of the machine dynamics	x	x	x	x
visualization of the machine ranges	x	x	x	x
collision control	x	x	x	x
numerical display of the machine positions and the time	x	x	x	x

Laminate design and analysis	essential	standard	expert	high-end
export laminate data to any FEA program	design pack	design pack	design pack	design pack
COMPOSITE STAR software included	design pack	design pack	design pack	design pack