Simulation Software
xTribo Viscoelastic

Dry friction
The tribology of non-lubricated systems is one of the last fields, where computer aided design and engineering methods are virtually non-existent. This is primarily due to the fact that dry friction depends on surface roughness on all scales down to the mircroscale. Reliable friction simulations require the contact area to be discretized with a resolution of few nanometers in two or three dimensions, which makes simulations nearly impossible on currently available hardware.

Instead, engineers are forced to use imprecise and difficult to use empirical rules. The most common rule, due to its simplicity, remains Coulomb's friction law, $(F_t = \mu F_n)$. It is well known that the "constant" of proportionality can change by an entire order of magnitude in some circumstances, but there are, unfortunately, few practical alternatives.

3D → 1D

The xTribo simulation software makes reliable dry friction simulations available to engineers and scientists. Based on the method of reduction of dimensionality, which was recently developed at the Technical University of Berlin, the simulation software calculates contacts 5 to 10 orders of magnitude faster than the fastest competing method. To achieve this, the 3D contact problem is transformed into a 1D model, which renders certain aspects of the real contact exactly. That this should be at all possible, may seem incredible, but the equivalence of the 3D and 1D models has been proven rigorously for a broad class of surface profiles and materials.

xTribo Viscoelastic

The currently available software package "xTribo Viscoelastic" can determine the dry friction force and contact length between a viscoelastic surface and a rigid indenter as a function of normal force and velocity. The software has the following characteristics:

Indenter shapes
It is assumed that the elastomer surface is planar, while the rigid indenter has one of the following macroscopic forms:

- cylindrical
- spherical
- conical

Isotropic surface roughness may be superimposed on the indenter.

Model of visco-elasticity

For the visco-elastic medium the Kelvin model is assumed, which is characterized by the (static) shear modulus and viscosity. Support for arbitrary linear rheology will be available in the next version of xTribo Viscoelastic.

Model of surface roughness
The roughness of the indenter is given by its power spectrum and is assumed to be isotropic. It can be defined by one of the following methods:

- Measured surface topography
- Randomly self-affine roughness of a given fractal dimension

- Arbitrary power spectrum

System requirements
Hardware: The software will run on standard personal computer. A modern CPU is recommended for more extensive simulations.

Operating System:
- Microsoft Windows XP SP3 (32 or 64 bit)
- Microsoft Windows 7 (32 or 64 bit).

On the method of reduction of dimensionality
The Software xTribo Viscoelastic is based on the Method of Reduction of Dimensionality developed in the Department of System Dynamics and the Physics of Friction, Berlin University of Technology, 2005-2012
xTribo Viscoelastic was developed to solve problems of static and dynamic contacts and to simulate friction between bodies with rough surfaces.
The method of reduction of dimensionality in contact mechanics is based on a mapping of some classes of three-dimensional contact problems onto one-dimensional contacts with elastic foundations. Recently, a rigorous mathematical proof of the method has been provided for contacts of arbitrary bodies of revolution with and without adhesion.
A short presentation of the method can be found here:

http://www.reibungsphysik.tu-berlin.de/menue/forschung/the_method_of_reduction_of_dimensionality

The basics of the method have been published in the following publications:

Popov V.L. Method of reduction of dimensionality in contact and friction mechanics: A linkage between micro and macro scales. – Friction, 2013, v.1, N. 1, pp.41-62. (Review Paper)

Pohrt R., Popov V.L. , Filippov A.E. Normal contact stiffness of elastic solids with fractal rough surfaces for one- and three-dimensional systems. – Phys. Rev. E, 2012, v. 86, 026710.

M. Heß, Über die Abbildung ausgewählter dreidimensionaler Kontakte auf Systeme mit niedrigerer räumlicher Dimension, Cuvillier-Verlag, Göttingen, (2011).

A short description of the method can be further found in Chapter 19 of the following book:

Popov V.L.: Contact Mechanics and Friction. Physical Principles and Applications. – Springer-Verlag, 2010, 362 p, ISBN: 978-3-642-10802-0.

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