Features and Applications
History & Structure

- 1973 • Beginning of software development
- 1987 • Founding of the company
- 1999 • Registration as SOFiSTiK AG

+ 80 employees

External branches:
- Athens (Greece)
- Pretoria (South Africa)

Numerous certificates & affiliations

HQ & Branches

AUTODESK
Authorised Value Added Reseller
Authorised Developer

SOFiSTiK
International Presence

6000+ clients
60+ countries

30 international distributors

10 competence centers
Software for the whole construction branch

Building  Bridges  Piles  Half-space  Tunnels

Membranes  Dynamics  Multi-Physics(CFD)  Geotechnics
Modular structure & Choice of interface

Pre-processing = Modelling Modules:
  - SOFiPLUS, SOFiMESH, SOFiLOAD

Processing = Solver Modules such as:
  - ASE, TENDON, ELLA, DYNA, MAXIMA, AQB, BEMESS

Post-processing = Results Modules:
  - WiNGRAF, Result Browser, Result Viewer, VB, C++, XLS SOFiCAD

SOFiPLUS(-X)  Revit  Rhinoceros  Teddy  winTUBE  SSD  SOFiCAD  Revit

SOFiSTiK Central DataBase (CDB)
SOFiPLUS(-X)
AutoCAD-based Modelling Interface
Full integration of AutoCAD tools

Full usability of AutoCAD tools (copy, rotate, 3D drawing, etc.)

Direct import of AutoCAD objects
- AutoCAD Lines ➔ Structural lines
- AutoCAD closed polygons ➔ Structural surfaces
- AutoCAD points ➔ Structural points

Native DWG format
Modelling in SOFiPLUS / AutoCAD

Integration in Analysis Workflow
- Automatic meshing from AutoCAD to SOFiSTiK
- Bidirectional dialog with SSD

Structure, Loads & Pre-stressing
- All types of elements together
- Modelling of loads and tendons
- Loading independent of meshing

Pre-settings for analysis
- Definition of linear and non-linear supports.
- Free definition of « groups »
SOFiSTiK – Revit Interface

FE Tools in the BIM Workflow
Modelling in REVIT

FEA Extension for Revit

• Goal: BIM R/C Building Designers can work with Revit and FEA Extension
• The SOFiSTiK Interface for Autodesk® Revit® Structure provides a seamless integration of FE analysis with all features of the SOFiSTiK software package.
• Automatic FE meshing can be started directly from Revit Structure to allow quick system changes of the calculation model.
• Immediate review of the structural model is possible starting ANIMATOR and WinGRAF directly from Revit.
Rhino & SOFiSTiK
Complex (free-form) geometries
SOFiSTiK integrated in Rhino

- Selective export of the geometry
- Full integration of SOFiSTiK FEA tools
- Structural properties and meshing options attribution

Export of 3D shapes: NURBS, lines, Rhino-surfaces (4.0)
Finite Element Analysis

Wide variety of elements available:
- Isotropic/anisotropic shell- & volume-elements.
- Layered elements (Fiber beam).
- Beam and cable elements.
- Pile elements.
- Membranes.
- Kinematical constraints.
- Nonlinear springs (failure, gaps, user defined stress-strain functions).
- Nonlinear bedding elements.
- Beam- and plate- nonlinear hinges
- Non-linear constraints
Analysis features

- Linear elastic, static.
- Load iteration, stability failure.
- **Non-linearity:**
  - Geometric
  - Material
  - Combination of geometric and material
- Warping effects on cross-sections.
- Creep and shrinkage, long-term deflections.
- Response spectra
- Push-Over-Analysis.
- Modal stationary and instationary response.
Analysis features

- Tension Stiffening (cracked concrete).
- Automatic update of non-linear stiffness.
- Plastification zones.
- Non-linear Beams.
- Construction stages.
- Primary states of stress and deformation.
- Activation – deactivation of elements or groups.
- Load combinations, Min/Max forces.

- Eigenfrequencies and eigenvalues.
- Forced vibrations.
- Time step method.
- General damper models & non-linear damping.
- Dynamic moving loads.
- Non-linear wind dynamics & CFD Analysis.
- Shape finding of cables or/and membranes.
- Inflated structures.
Dynamic & Seismic Analysis

- **Solvers**
  - Sparse Solver
  - Iterative Conjugate Gradient Solver
- **Eigenvalue Solver**
  - Simultaneous vector iteration
  - Lanczos
  - Rayleigh.
- Non-linear damping.
- **Response spectra**

- **Time History**
  - with modal analysis.
  - with direct analysis
- Non-linear wind analysis (SOFiLOAD-DW).
- Vehicle-structure-interaction.
- **Moving loads.**
- **High-speed-trains.**
- Harmonic load generator.
- Push-over analysis

...and a lot more...
### Post-processing

**Reports**
- Full numerical & graphical reporting.
- User-defined macros for standard result output.
- Free input of user-texts and -graphics
- Automatic update after new calculation

**Graphics**
- Interactive database evaluation with true scaling.
- Multiple-filter functions.
- Open-GL Animator for plausibility checks and movie files.

**Export**
- graphics via Copy/Paste and standard formats (PS, GIF, JPEG, etc.) to other applications.
- Excel, Word & PDF.
- VRML for virtual flight through the structure.
Steel Connections with SteelCon

**SteelCon** – Steel Connections.

**Design of steel connections**
- Use of analysis and design results from the database
- Library of standardized connections
Lightweight Structures

- Analysis of the entire system with the combination of different types of elements such as beams, slabs, walls and shells using different materials like steel, glass, concrete and membranes
- User defined materials
- User defined stress-strain curves for material and spring elements
- Construction stages
- Partial system failure
- 3rd order theory/full geometric nonlinear analysis
- Warping torsion
- Catenary effects
- Post-tensioned shells
- Non-linear material behavior for concrete or metallic materials
- Local and global stability analysis (plate buckling, lateral buckling)
Membrane Structures

- **Form-finding**
  - with the FE method following the membrane theory
  - with inner pressure
- **Pre-stressing**
  - orthotropic.
  - Isotropic with minimum surface (membrane)
- Iterative analysis with interaction between primary and secondary structure
- Consideration of the shear stiffness of the membrane fabric
- Compression failure for the determination of wrinkling effects
- **Cutting patterns**
  - consideration of material compensation
Membrane Structures

Graphical definition in SOFiPLUS or Rhino

Form-finding

Cutting pattern
Geotechnics / Geomechanics

Soil-Structure Analysis

WinTUBE
Graphical pre-processing for tunnel

FIDES CAM-PARTNER
Analysis of retaining walls

Graphical pile modeling & analysis
Transient Potential Analysis

HYDRA – Seepage and Thermal Analysis

Classical potential problem.
- Ground water flow.
- Heat conduction (convection) incl. radiation border conditions.
- Electrical and magnetic fields.
- Torsion/shear problems on a cross-section level.
- Membrane solutions.

Differential equations
- Laplace
- Poisson
DOLFYN – Computational Fluid Dynamics / Multi-Physics.

Field of application

- Fluid Mechanics (Navier-Stokes equations).
- RANS family turbulence models.
- Free surfaces for fluids.
- Heat conduction and convection.
- Combustion.
- Melting and solidification.
- Elasticity and plasticity of soils.
Bridges

Any type of structural bridge system

- Cable-stayed
- Box girder
- Plate girder
- Slab
- Composite
- Suspension
- Slab/beam
Parametric Bridge Design

**CABD** – Computer Aided Bridge Design

**Definition of bridge with parametrical input → Dynamical change in the model**

- Fully parametric cross section as basic sections with:
  - Reinforcement layers
  - Location of stress points
  - Location of shear cuts
  - Definition of torsion box
  - Reference points for PT geometry
  - Shear lag
  - Internal dependency
  - Axis-related variables
  - Support & joints as placements on axis
  - Tendon geometry related to axis
Pre-stressing

Different types of pre-stressing
- Internal / external tendons.
- Pre- and post-tension.
- For beam- & shell elements
- In haunched beam/plate

Definition
- 3D Geometry (spline, polyline, etc.)
- Free-shape modelling in AutoCAD
- Graphical editor
- Eccentric duct position.
- Integrated in CABD (= axis-based)

Modelling/Analysis
- Detailed loss calculation, including friction, wedge slip, time-dependent effects etc.
- Construction sequence
Composite Bridges

Any type of composite structure
- Steel + Concrete
- Concrete + Concrete

Analysis model
- Thin-walled section (=constant shear flow)
- Thick-walled section
- Free combination of Beam + Shell
- Construction stages

Analysis & Design
- Time-dependent effects (creep & shrinkage, etc.)
- Design incl. Class 4 sections
- Cracking of concrete over supports
Construction Stages
Bridge & Traffic Loads

Bridges loads with **CSM**
- Self weight activated together with Stages
- Creep & Shrinkage based on time-axis
- Additional loads:
  - Additional dead load
  - Temperature gradient and global change.
  - Settlement
  - wind on loaded and unloaded deck

**Traffic loads**
2 approaches:
1. Load stepping with defined increment + envelop of all steps
2. Influence lines/surfaces analysis
Implemented norms

**Eurocode**
- EN 1992
- EN 1993
- EN 1994
- EN 1995
- EN 1996
- EN 1997
- EN 1998
- EN 1999

**DIN (Germany)**
- DIN 1045 (1988)
- DIN 1045-1 (1999)
- DIN 18800 (Nov. 1990 + Nov. 2008)
- DIN 1052 (Apr. 1988)

+ National Annexes

**OENORM (Austria)**
- OENORM B 4700 (1995)
- OENORM B 4750 (2000)
- OENORM B 4253 (1989)
- OENORM B 4253 (1989)

**SIA (Switzerland)**
- SIA 162
- SIA 262
- SIA 263
- SIA 265

**BS (UK)**
- BS 8110 (1997)
- BS 5400 (1990)
- BS 5950 (2001)

**ACI + AASHTO (USA)**
- ACI 318-M (1999)

**SNIP (Russia)**
- IS (India)
  - IS 456 (01/2002)
  - IRC

**GB (China)**
- GB 500100 (2002)

**NBR (Brazil)**
- NBR 6118 (2003)

**NF (France)**
- BAEL-BPEL 91/99

**EHE (Spain)**
- DM 96

**DMI (Italy)**
- JRA (2002)

...and many more!!
National annexes for EN1992-1-1
Design – Shell & Plate Elements

ULS Design

• Each reinforcement layer and direction
• Punching

SLS Design

• Crack verification
• Cracked deflection

Special features

• Non-lin. Design
• Pre-stressed slabs
Design – Beam Elements

Concrete Sections

Design
• Auto. selection of envelopes/results
• Non-linear design
• Results per reinforcement layer
• Different use per layer
• All geometries:
  • T-Beam
  • Box
  • Etc.

Verifications
• Decompression +/-
• Cracks
• Stress/strain
Design – Beam Elements

Steel / Composite Sections

- c/t Verification
- Section Class
- Class 4 Design
- Composites Sections
- ...