Computational Design & Advanced Surfacing with Rhino and Grasshopper

Course Objectives

1. To provide professionals with a structured learning path from fundamental 3D modeling to advanced surface and parametric design workflows.
2. To develop strong NURBS modeling expertise, enabling participants to create accurate, complex, and production-ready geometry.
3. To build advanced surface modeling capabilities including continuity control (G0, G1, G2), surface analysis, and quality validation.
4. To introduce parametric thinking and computational design principles using Grasshopper for automation and generative modeling.
5. To integrate modeling, visualization, documentation, optimization, and export workflows aligned with real-world industry standards.

Target Audience

This course is ideal for:

- Architects and Architectural Designers
- Mechanical & Industrial Design Engineers
- Product Designers and Automotive Modelers
- BIM & Computational Design Professionals
- CAD Draftsmen upgrading to advanced surfacing & parametric workflows
- Design students and professionals seeking end-to-end Rhino + Grasshopper mastery

Course Outcomes

By the end of the course, participants will be able to:

1. Confidently navigate and utilize Rhino's full modeling environment for precise 2D and 3D design development.
2. Create complex freeform and Class-A style surfaces using advanced NURBS techniques and surface continuity control.
3. Analyze and validate surface quality using Zebra, curvature, draft, and diagnostic tools.

4. Convert surface models into manufacturable solids and prepare optimized files for CNC, 3D printing, and CAD interoperability (STEP, IGES, STL, DWG).
5. Develop parametric models in Grasshopper using data trees, attractor systems, transformations, and surface panelization techniques.
6. Automate repetitive modeling tasks and improve productivity using customization and scripting concepts.
7. Execute an integrated capstone project combining advanced surfacing and parametric workflows suitable for professional portfolios.
8. Apply Rhino and Grasshopper effectively in architecture, product design, industrial modeling, and computational design environments.

Course Outline

The course comprises **72**-hours of theory and labs and is divided into **18** different Modules. Each chapter will be followed by hands-on lab exercises to reinforce learning and gauge understanding of the topics covered.

Table of Contents:

Module 3: Accurate Modeling Techniques

- Object snaps and SmartTrack
- Grid snap, Ortho, distance & angle constraints
- Construction planes and coordinate systems
- Sub-object selection
- Precision modeling workflow

Module 4: Basic Modeling Tools

- Drawing curves (Line, Polyline, Arc, InterpCrv)
- Creating surfaces (Extrude, Revolve, Loft, Sweep)
- Boolean operations (Union, Difference, Intersection)
- Move, Rotate, Scale, Mirror
- Join, Explode, Trim, Split

Module 5: Editing & Modifying Geometry

- Control point editing
- Rebuilding and refitting curves
- Surface trimming and extensions
- History-enabled modeling
- Flow along surface

Module 6: Organization & Documentation

- Layers, groups, and blocks
- Worksessions
- Annotation tools (Dimensions, Text, Leaders)
- Layouts and title blocks
- 2D drawing extraction

Module 7: Rendering & Visualization

- Materials and textures
- Lighting setup

- Environment settings
- Render preview and Raytraced mode
- Presentation-ready outputs

Module 8: Advanced NURBS Surface Fundamentals

- Surface direction and isocurves
- Degree, spans, and knots
- Surface parameterization
- Surface rebuilding strategies

Module 9: Advanced Surface Creation Techniques

- Advanced Loft options
- Sweep 1 Rail & 2 Rail best practices
- NetworkSrf workflows
- EdgeSrf and Patch
- BlendSrf and transition control

Module 10: Surface Continuity & Quality

- G0, G1, G2 continuity
- MatchSrf techniques
- Tangency vs curvature continuity
- Surface fairing and refinement

Module 11: Surface Analysis & Validation

- Zebra analysis
- Curvature graph
- Environment map analysis
- Draft angle analysis
- Deviation checks and diagnostics

Module 12: Complex Freeform & Class-A Concepts

- Multi-surface assemblies
- Organic form modeling
- Controlling edge flow
- Surface smoothing techniques
- Managing complex data

Module 13: Surface to Solid Integration

- Joining surfaces into polysurfaces
- Creating closed solids
- Shelling and thickening
- Boolean operations with surfaces
- Repairing geometry

Module 14: Customization & Productivity

- Interface customization
- Aliases and macros
- Basic RhinoScript concepts
- Automating repetitive workflows

Module 15: File Management & Collaboration

- Importing and exporting (STEP, IGES, STL, DWG)
- Tolerance management
- Model cleanup and optimization
- Preparing models for CNC & 3D printing

Module 16: Introduction to Grasshopper

- Grasshopper interface and components
- Parameters and data flow
- Basic geometry creation
- Working with sliders and inputs
- Baking geometry into Rhino

Module 17: Parametric Modeling Techniques

- Data trees and data management
- Lists and pattern generation
- Attractors and parametric control
- Transformations in Grasshopper
- Panelization and surface subdivision

Module 18: Advanced Grasshopper Applications

- Parametric façade design
- Pattern generation on surfaces
- Optimization concepts
- Linking Rhino and Grasshopper workflow
- Real-world case study project