



Introduction:

Surface modelling can be a black-art. It can be a lot of fun or a very painful experience depending on your level of skill.

There is a learning curve that needs to be climbed in order to achieve a certain level of competence. This is particularly true when it comes to generating good quality surfaces.

I am fortunate to have worked within world class design teams where my methodologies and skills have been developed and utilised.

My approach when using CATIA is to use procedural geometry as far as possible, use repeatable and robust procedures, and apply innovative and novel methods to realise simple concepts.

The vast array of surfacing and analysis tools in CATIA can be daunting to the uninitiated. However, I have developed a methodology to extract and package fairly complex tasks within a simple and robust framework.

Therefore the purpose of this article is to give you some insight into the world of surfacing for aerodynamic purposes.

It provides a glimpse of the tools that I developed for aerodynamic designers at a large European civil aircraft company.



CADlab expertise lies in bringing together the two domains of CAD design and software development by using innovative software based solutions to help the aerodynamics design engineer to focus on the product and not the toolset.



- A suite of tools invented to enable the Wing Shape engineer to effortlessly create and smooth wing surface geometry within CATIA V5.
- Provides the aerodynamicist/design engineer the capability to concentrate on the product design and not necessarily on learning to expertly use all the requisite workbenches in CATIA.
- Allows the easy creation of parametric geometry which is robust, flexible and permits judicious user input in an aerodynamically intuitive manner.



Example

- The example shown in the following video uses a NACA section with an arbitrary planform and scale to build a set of wing-type surfaces.
- The twist, height, scale and position of the sections can be changed on a local or global basis.
- The leading edge, spars box and trailing edge of the sections can be tailored individually or as a family.
- The video also shows the use of some typical analysis tools to steer the design iterations.

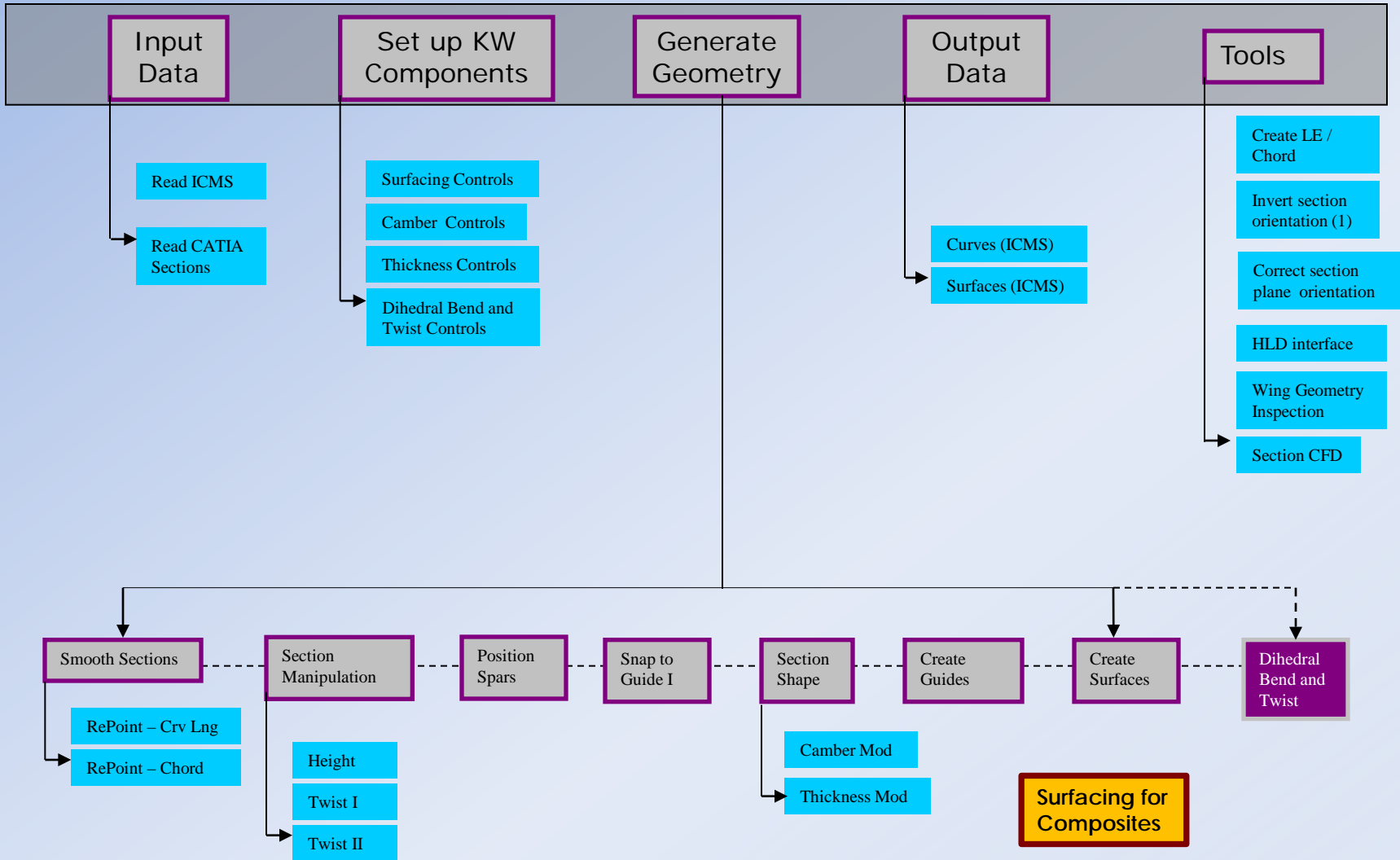
Capabilities:

- Control shape evolution in a robust and rapid manner.
- Capture, reuse and exploit existing design principles.
- Adapt methodology to any geometry.
- Rapid generation of high quality surfaces for composites design and manufacture.
- Link geometry to 3D Optimisation workflow.



Toolset Schematic

Visualise Explore Refine

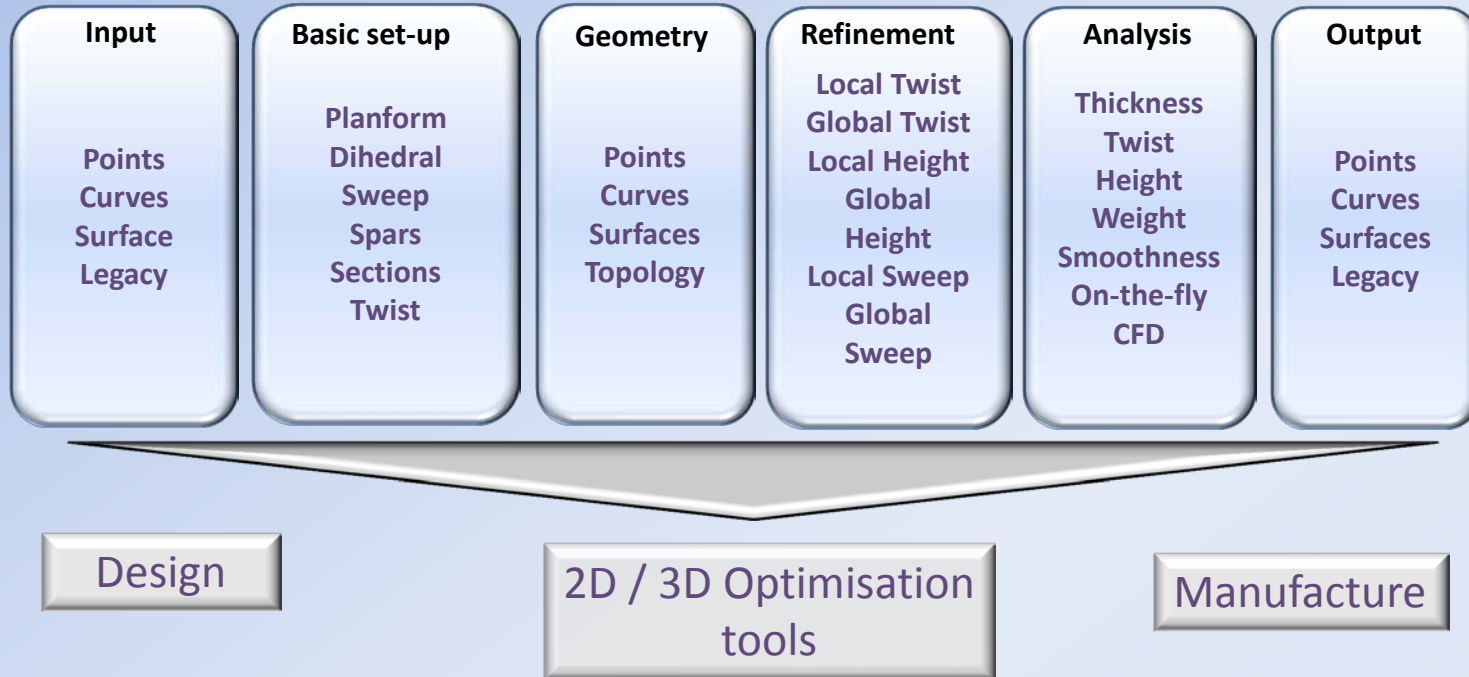


EXAMPLE OF TOOLS DEVELOPED FOR AERODYNAMIC DESIGNERS



Modules

Visualise Explore Refine

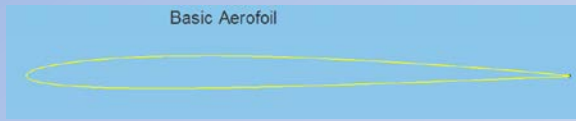


EXAMPLE OF TOOLS DEVELOPED FOR AERODYNAMIC DESIGNERS

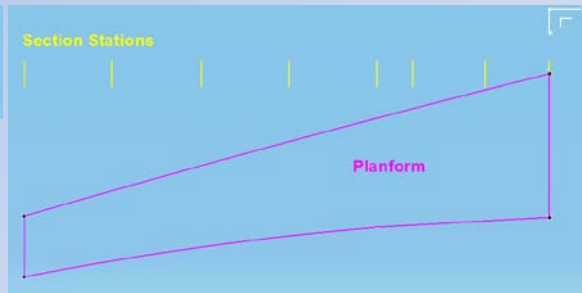


Workflow to create a set of surfaces through a network of aerofoil sections.

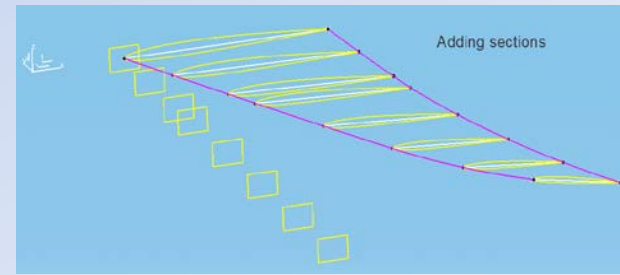
Visualise Explore Refine



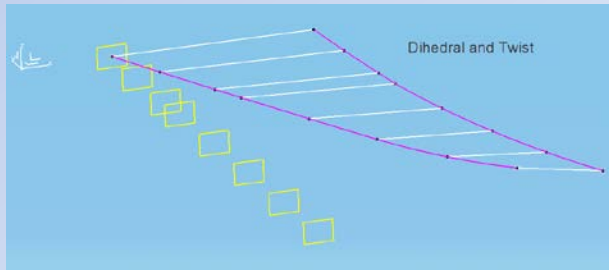
Aerofoil section – created from points



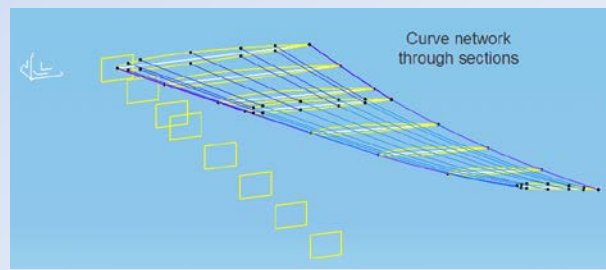
Planform



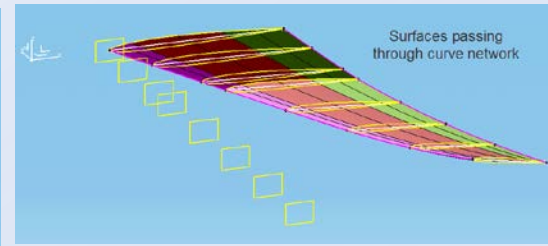
Placing sections



Adding dihedral and twist



Create curve network

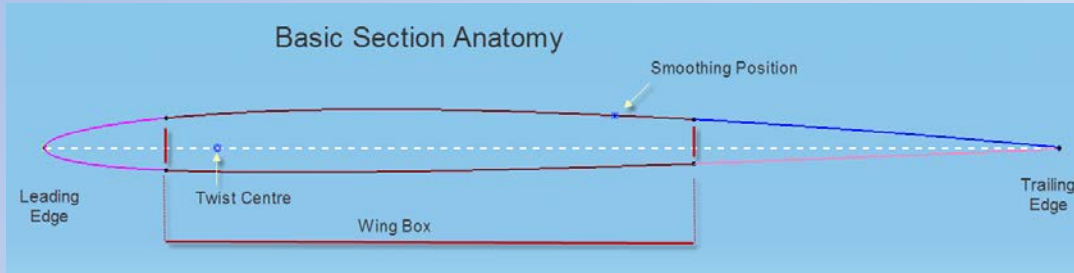


Create surfaces

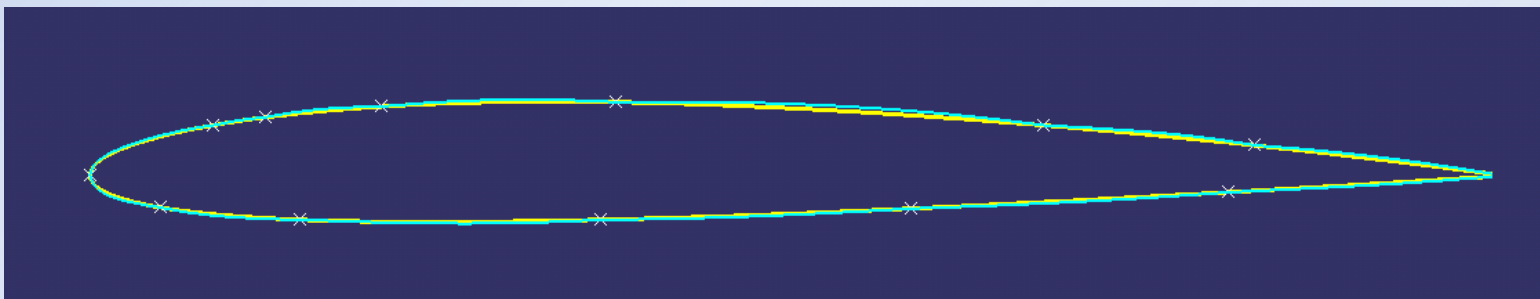
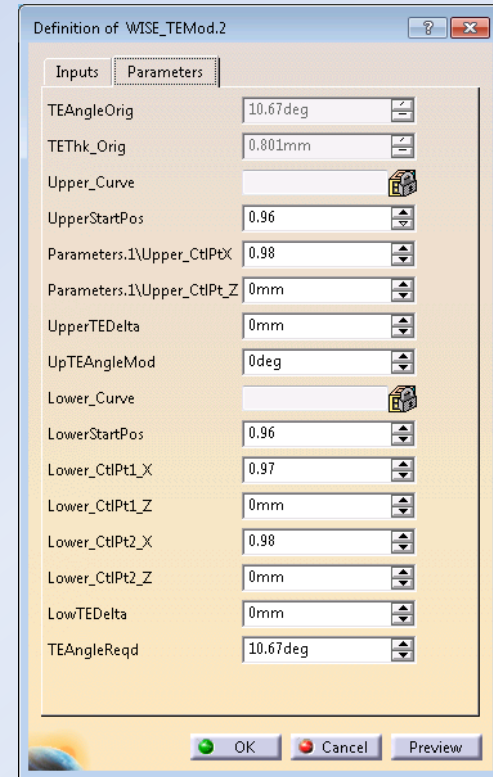
Benefits: Robust, quick and obeys quality standards



Anatomy of an intelligent aerofoil section



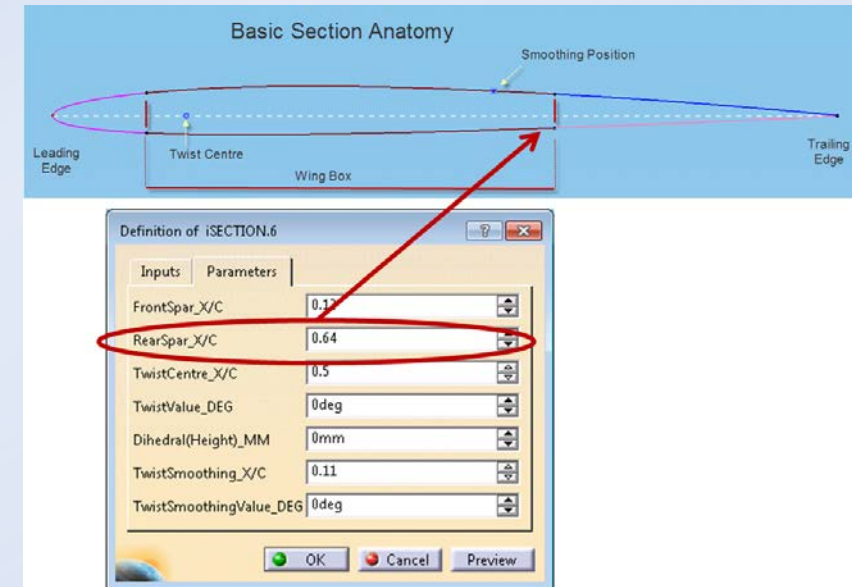
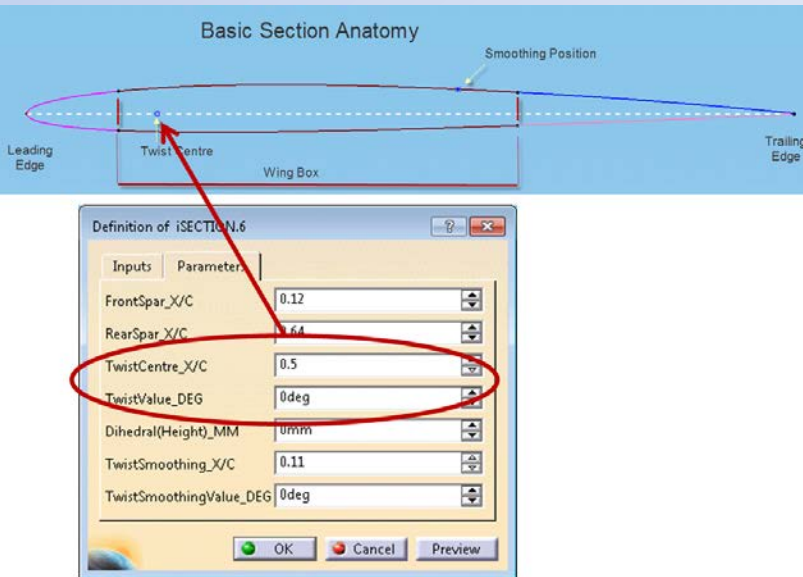
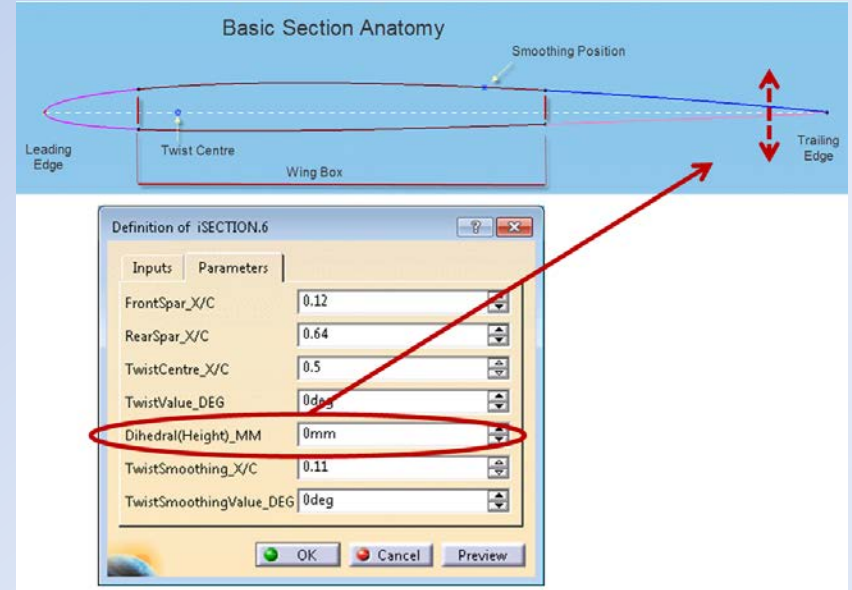
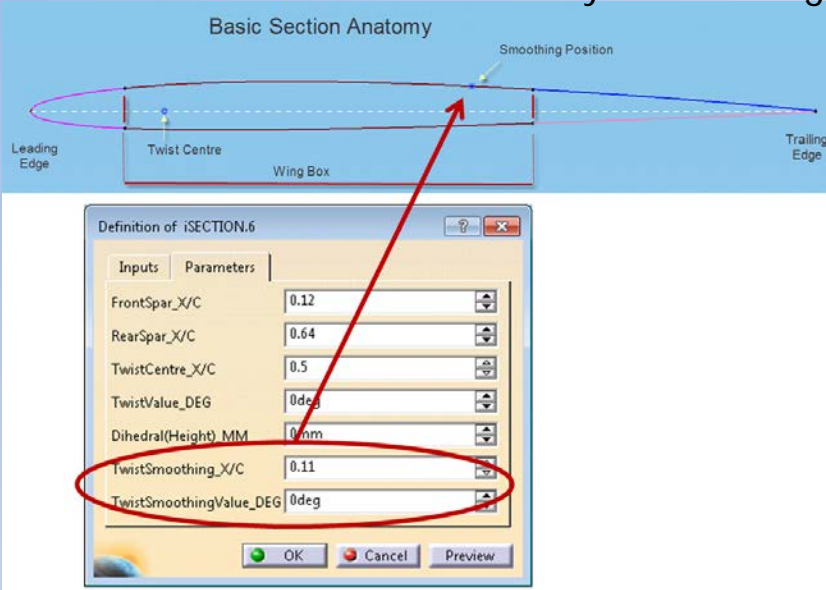
Impose intelligent features on the section
Leading edge, trailing edge, spars, thickness, twist
centre, twist, height



EXAMPLE OF TOOLS DEVELOPED FOR AERODYNAMIC DESIGNERS



Anatomy of an intelligent aerofoil section

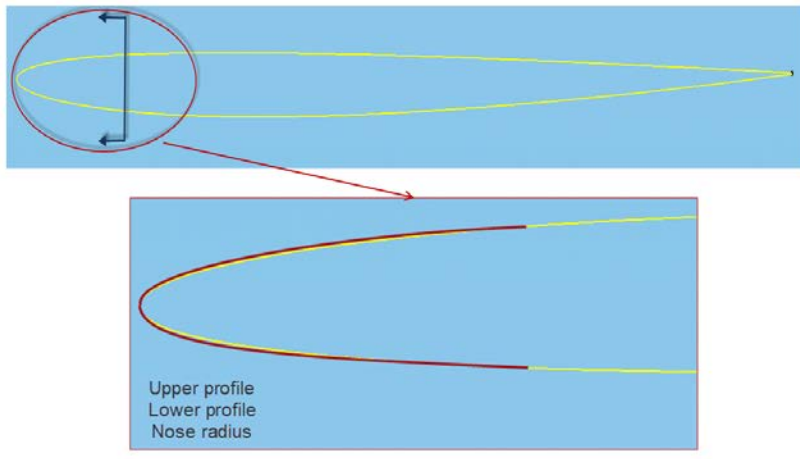


Visualise Explore Refine

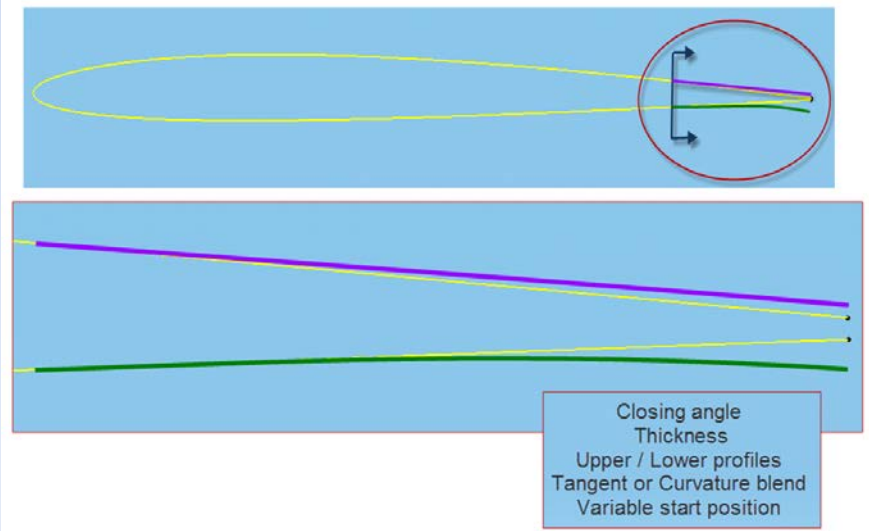


Leading and trailing edge refinement options

Leading edge modifications

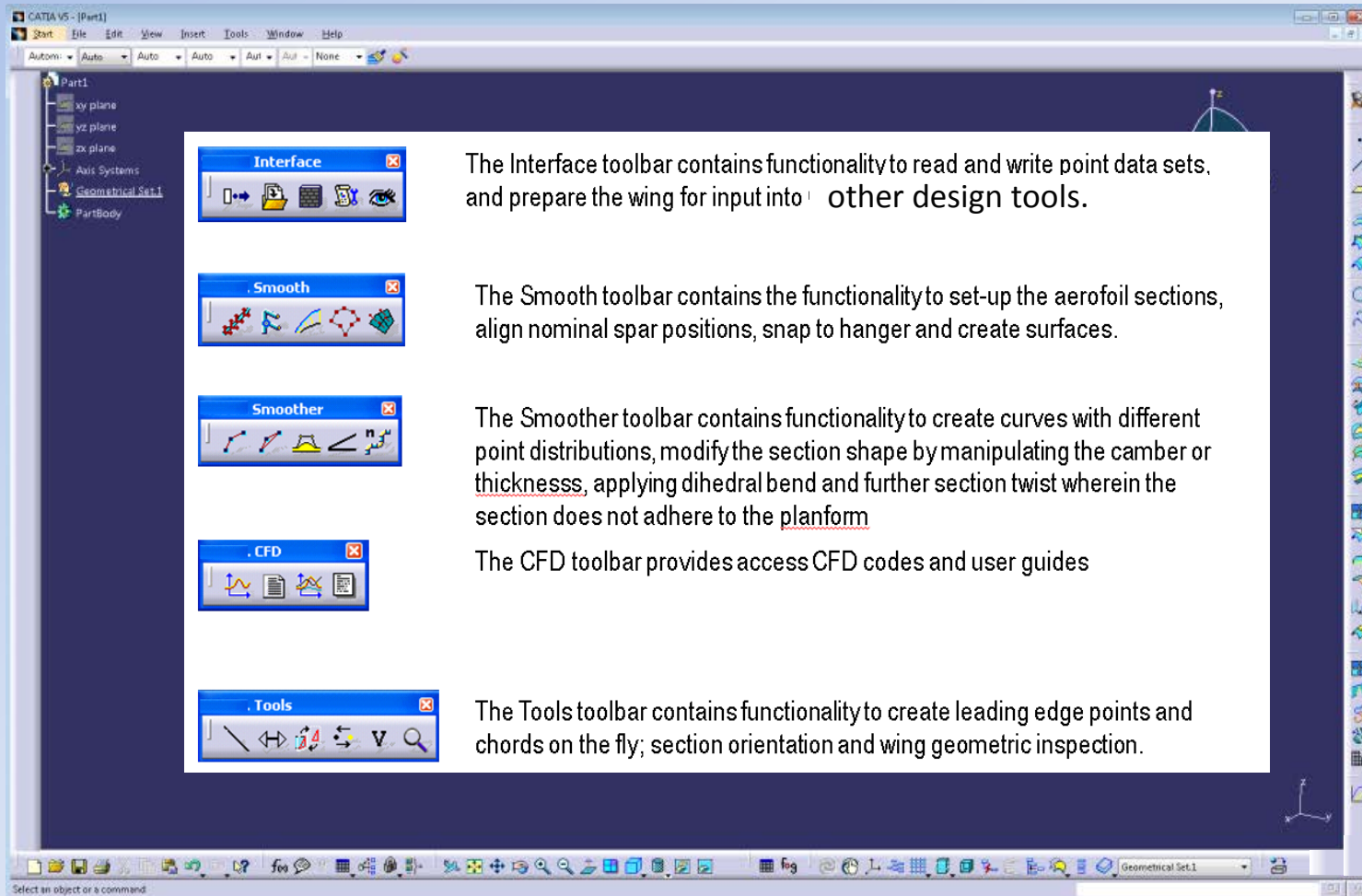


Trailing edge modifications



Look and Feel - Option 1

Scripts accessed via a separate graphical user interface running alongside CATIA

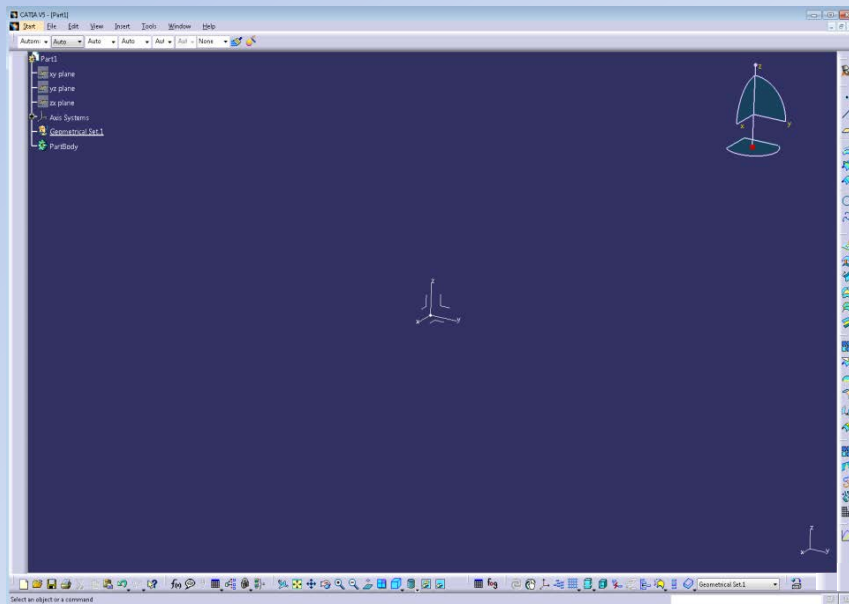


The screenshot shows the CATIA V5 software interface with a custom GUI overlay. The overlay consists of five toolbars, each with a set of icons and a corresponding text description:

- Interface**: The Interface toolbar contains functionality to read and write point data sets, and prepare the wing for input into other design tools.
- Smooth**: The Smooth toolbar contains the functionality to set-up the aerofoil sections, align nominal spar positions, snap to hanger and create surfaces.
- Smoother**: The Smoother toolbar contains functionality to create curves with different point distributions, modify the section shape by manipulating the camber or thickness, applying dihedral bend and further section twist wherein the section does not adhere to the planform.
- .CFD**: The CFD toolbar provides access CFD codes and user guides.
- .Tools**: The Tools toolbar contains functionality to create leading edge points and chords on the fly; section orientation and wing geometric inspection.

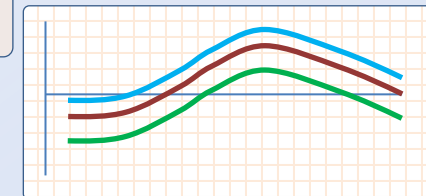
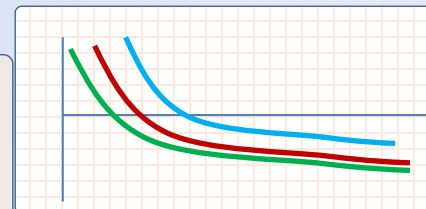
Look and Feel - Option 2

Scripts accessed via a separate graphical user interface running alongside CATIA



External GUI with the following elements:

- TWIST
- HEIGHT
- THICKNESS
- CAMBER
- Send to CATIA
- Get from CATIA



Benefits

- Provide all users with same level of modelling skill and standards.
- Palette of tools to rapidly steer iterations for shape design.
- Reduce product development costs by improving design and development efficiency and reducing errors for downstream usage.
- Generate surfaces suitable for Composites design, solid modelling and manufacture.
- Easily interface with non-CATIA applications.
- Capture and reuse company know-how while protecting intellectual property.
- Deploy automation capabilities to reduce cycle times by 80 – 90 %.
- Exploit modular architecture to develop capability.



Curves

Visualise Explore Refine

2D/3D
SPLINES

3D CURVES

ISOLATED
CURVES



Smoothing

Point Density

Cell Reduction

Remove Inflections

Control Curvature

Dense at Leading Edge

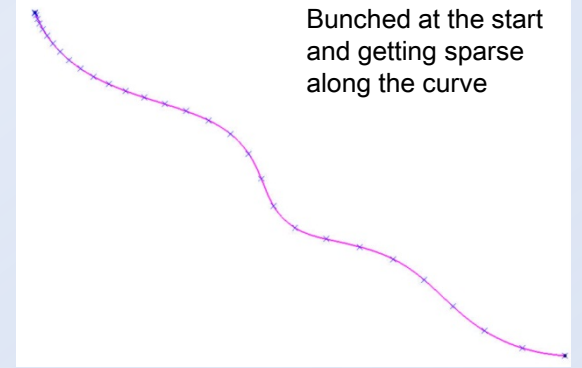
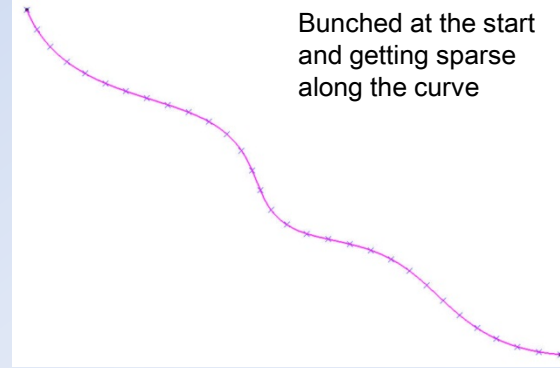
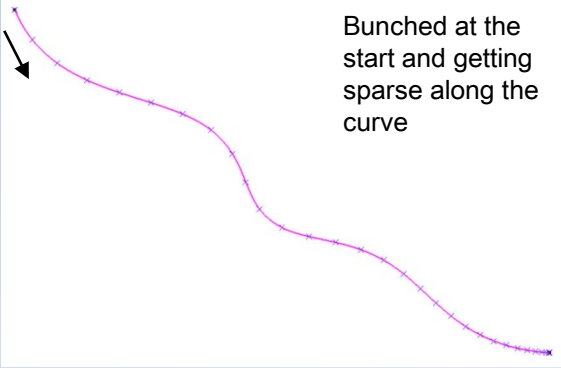
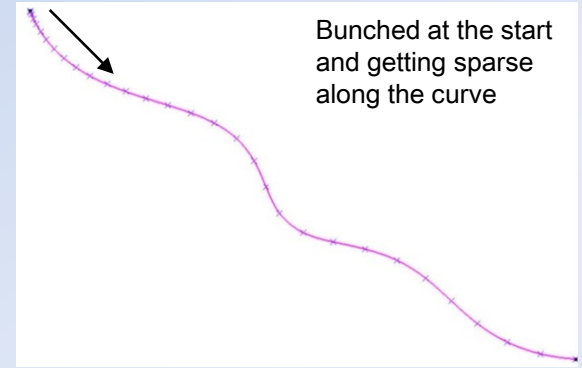
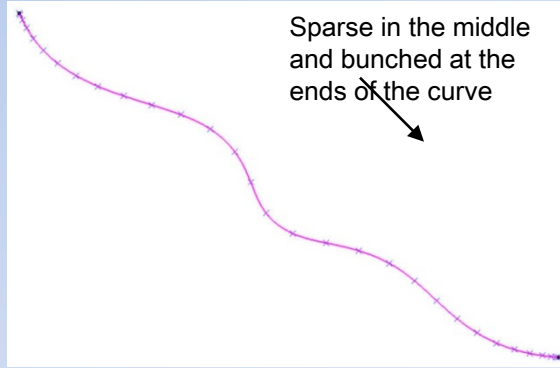
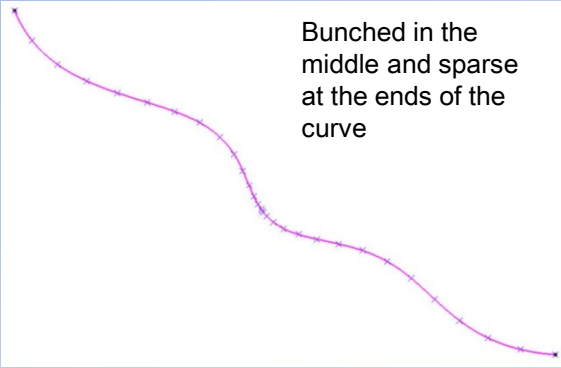
Sparse at Leading Edge

Dense at Trailing Edge

Good Curves make Good Surfaces



Curves



Functionality

1. Change wing parameters in an aerodynamically intuitive manner
2. Modify the wing topology to control shape evolution
3. Produce high quality surfaces in a quick and robust fashion
4. Change the wing shape to suit different loading conditions
5. Perform on-the-fly analysis of section or wing configurations
6. Streamlined interface to other toolsets
7. Interface – Points (Text file or IGES or STEP),or Curves
8. Any Axis orientation
9. Trailing Edge – Curved, Straight, Kinked
10. Leading Edge – Curved, Straight, Kinked
11. Any number of aerofoil sections
12. Line of flight or Angular Section mapping interface
13. Interactive Twist manipulation by curve modification
14. Interactive dihedral manipulation by curve modification
15. Inbuilt Surface Isoparm control , lightness
16. Aerofoil section segmentation and smoothing
17. Aerofoil section swap-out
18. Easy to change forward and aft boundary positions
19. Ideal for surfacing for Composites Design by reducing segmentation and ensuring high quality surfaces
20. Detailed and rapid interrogation of the geometry. Simple and flexible output format

