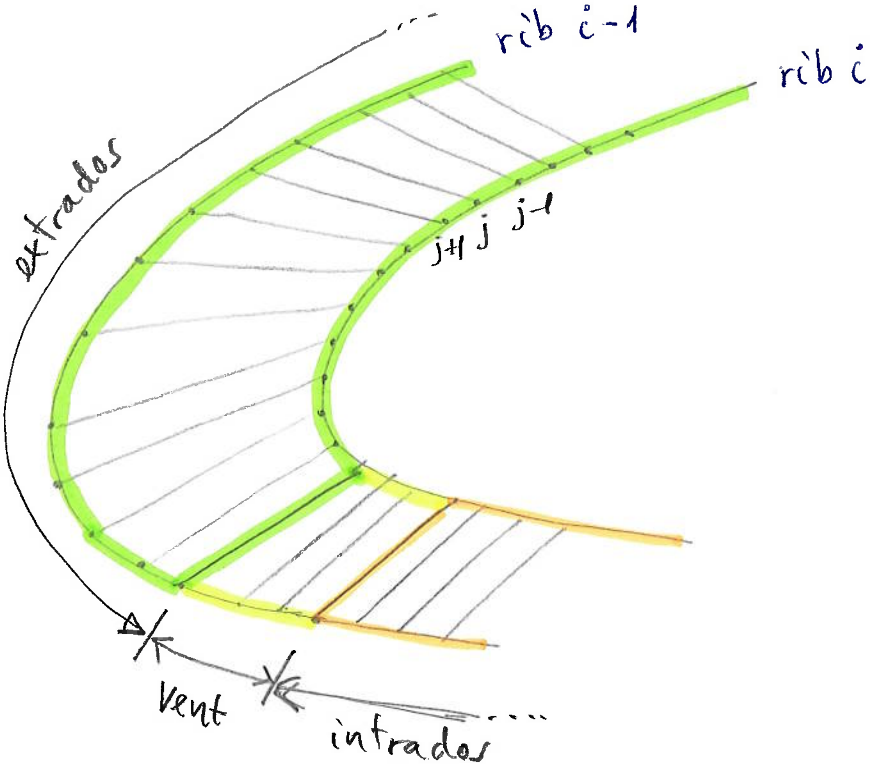
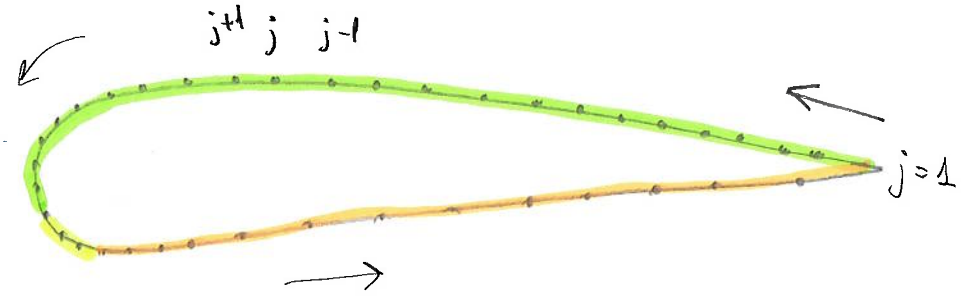
3D-SHAPING PROGRAMMING STRATEGY

For each panel between rib i-1 and rib i

Ribs 0, 1, 2, ..., i, ..., nmaxribs



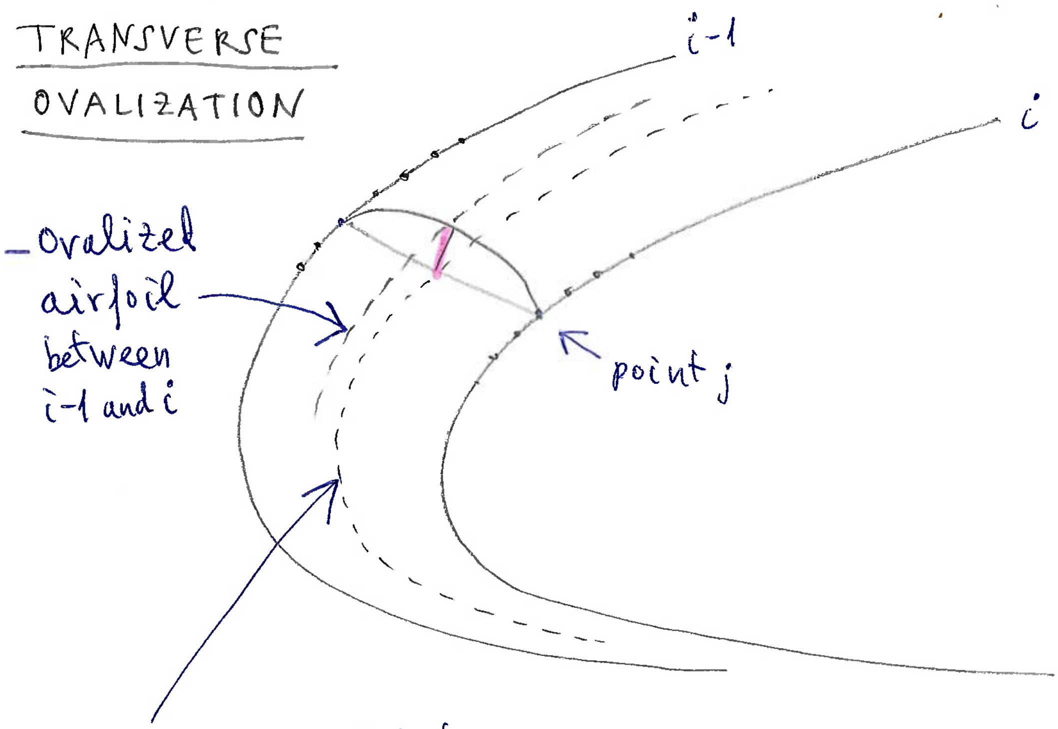
Each airfoil have npoints



j = 1, 2, 3, ..., j, ..., npoints

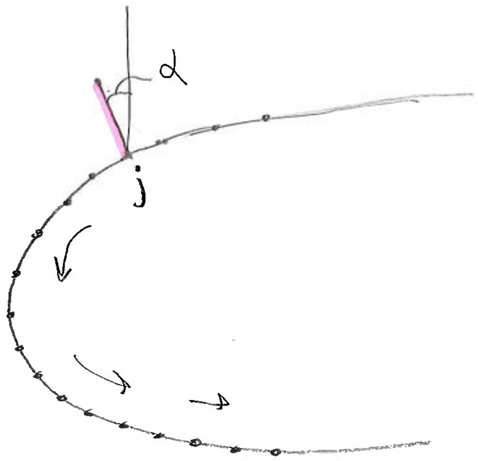
Consider :

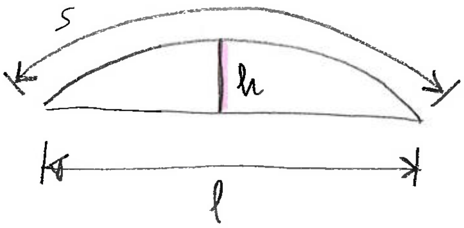
TRANSVERSE OVALIZATION



– Virtual airfoil between i-1 and i

– straight distance between corresponding points j in airfoil i-1 and i (l)





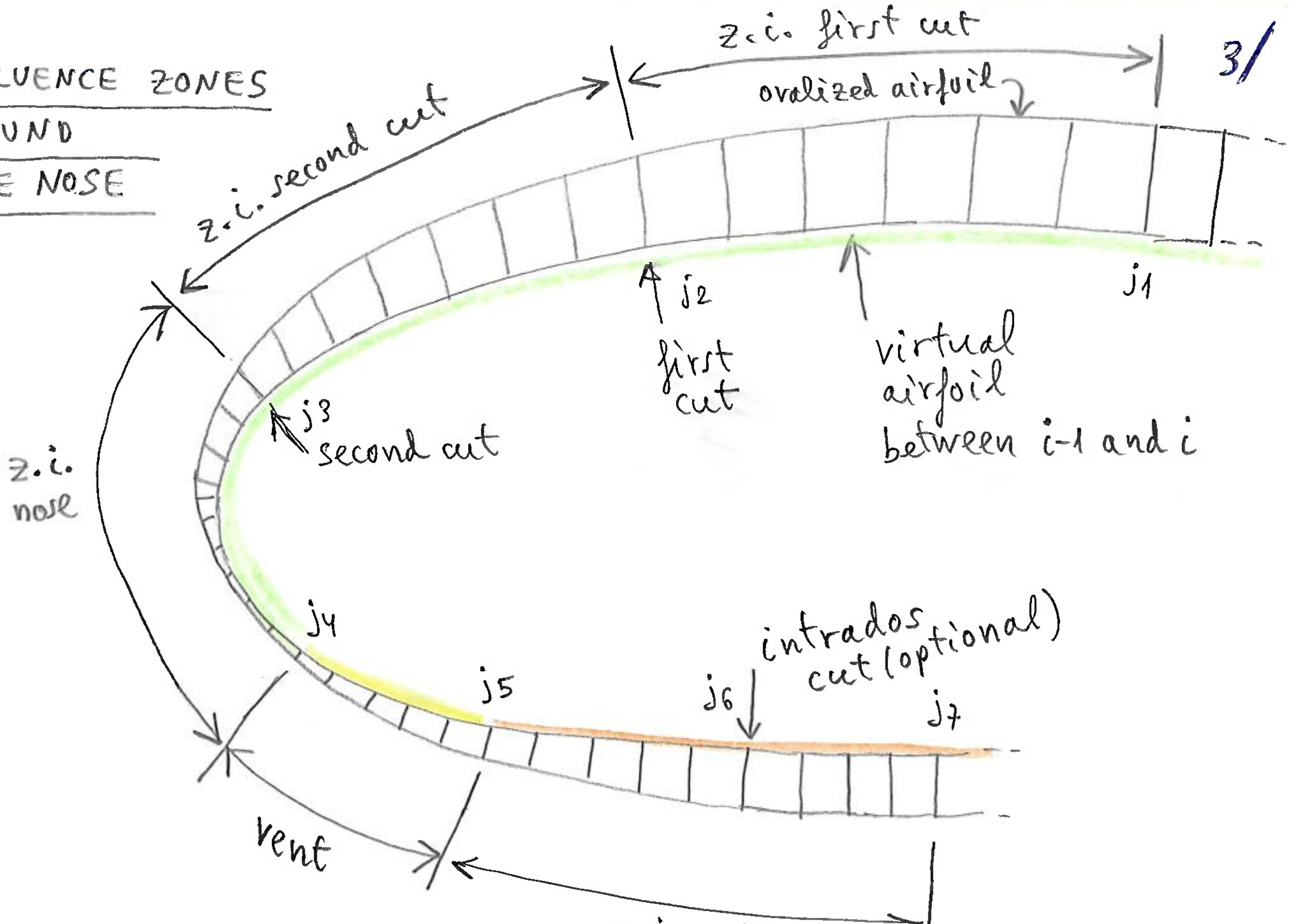
– Ovalized distance (s)

– Ovalization height (h)

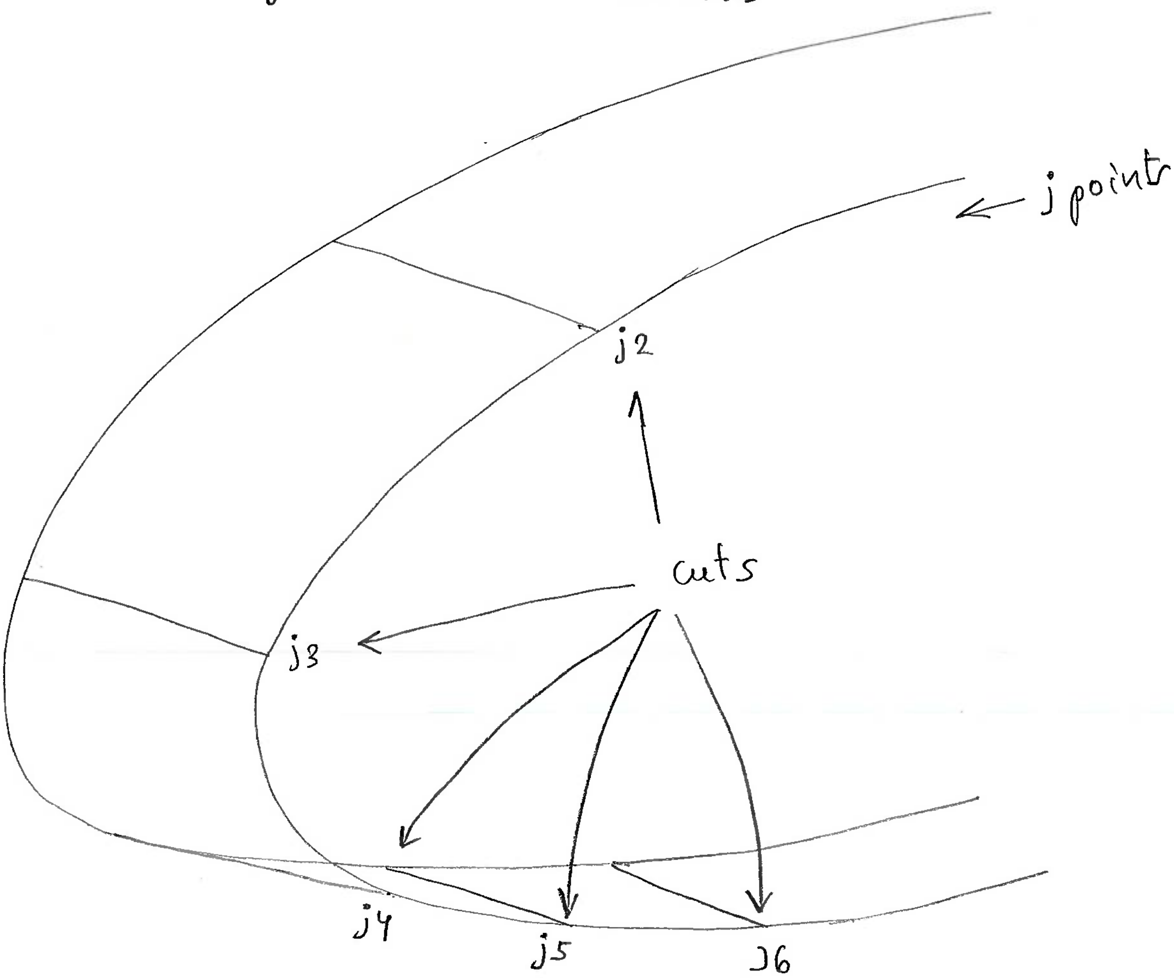
– Sector plane angle (α)

} transverse ovalization parameters

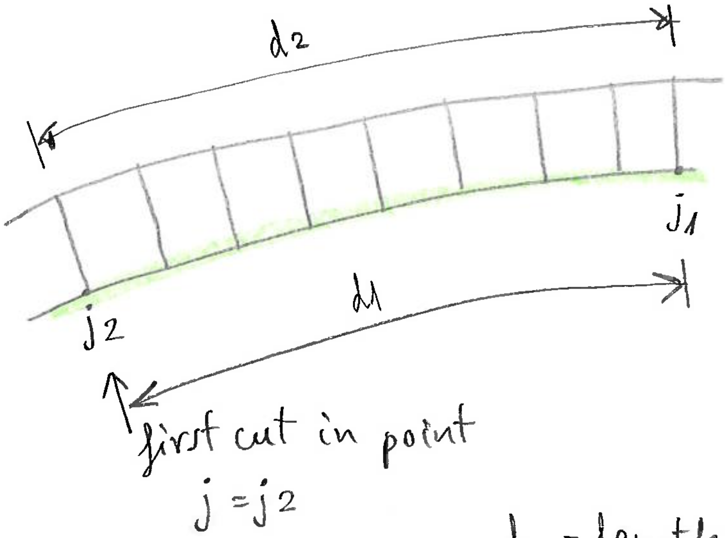
INFLUENCE ZONES AROUND THE NOSE



z.i. = zone of influence



Consider z.i. of first cut in detail



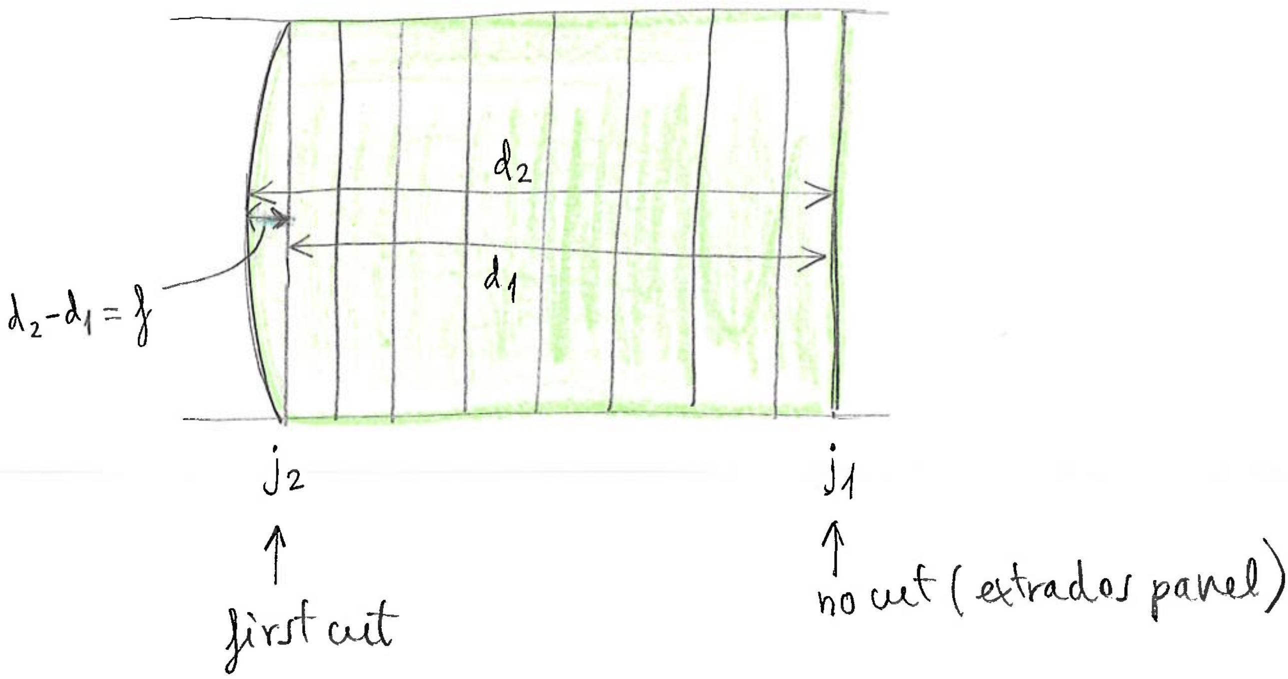
$(\Delta_1 = d_2 - d_1)$

d_1 = length between j1 and j2 along virtual airfoil

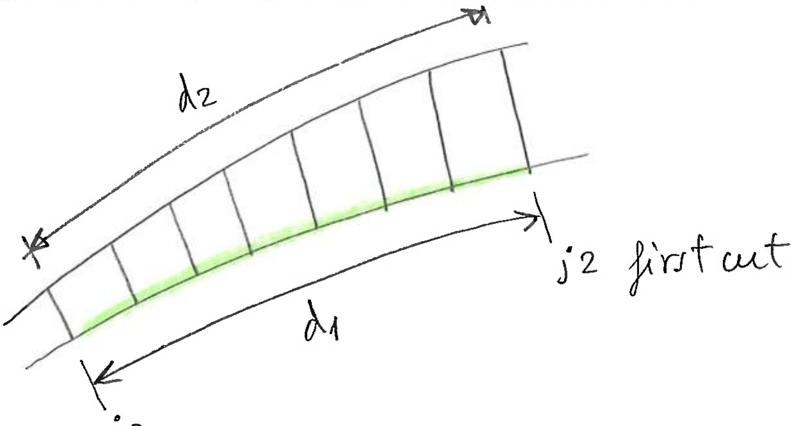
d_2 = length between j1 and j2 along ovalized airfoil

In most cases $d_2 > d_1$ then...
if we want the panel have a uniform tension, we need to extend its center part

3D-shaping estrategy

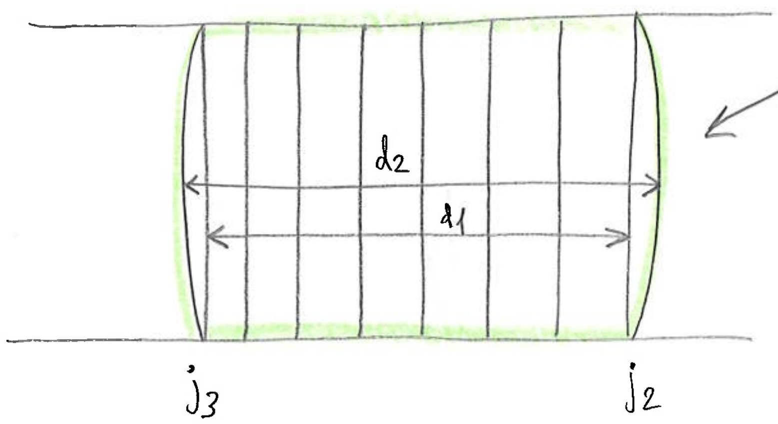


Consider z.i. of second cut in detail



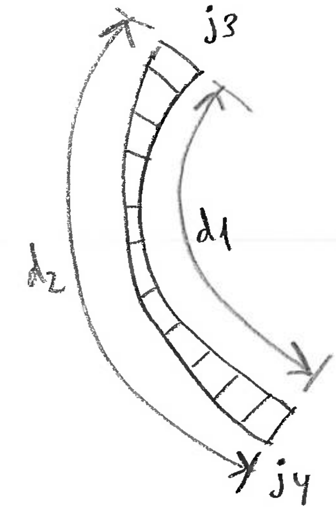
$d_2 > d_1$

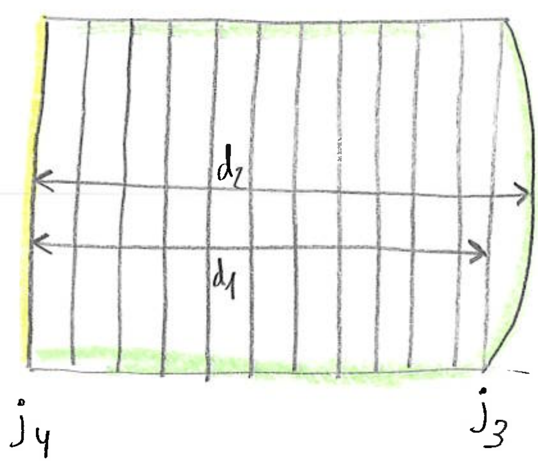
$(\Delta_2 = d_2 - d_1)$



3D-shaping strategy: we enlarge the panel in its central part to avoid stretching

Consider z.i. of nose in detail

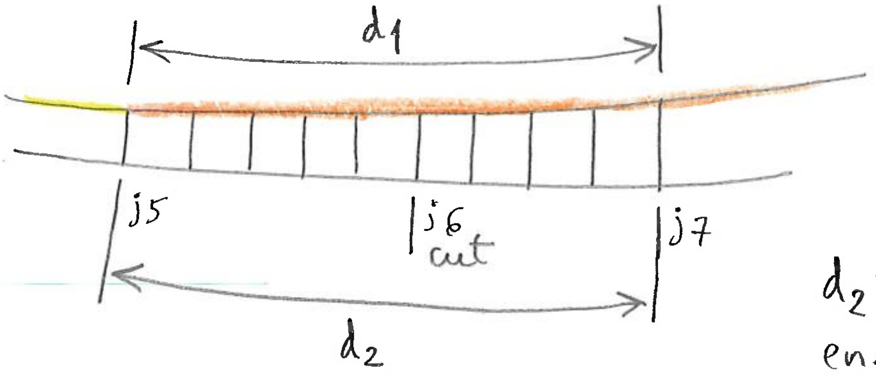




$d_2 > d_1$

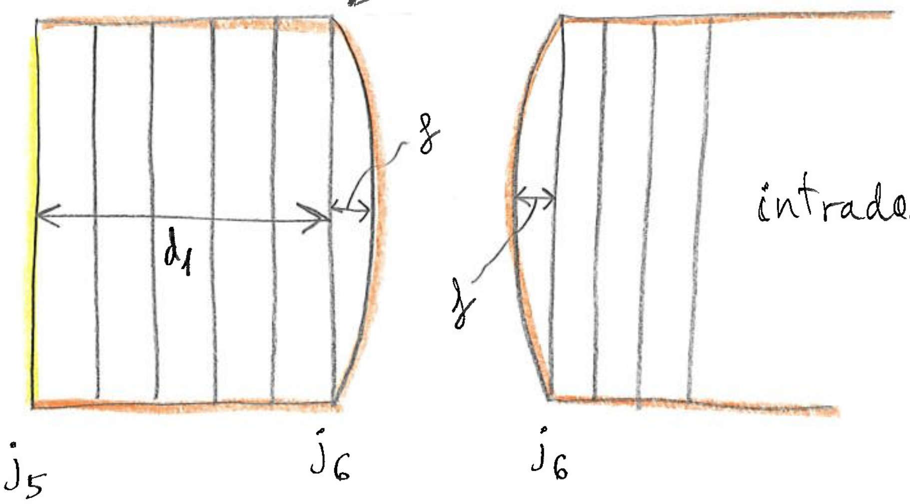
$(\Delta_3 = d_2 - d_1)$

Consider z.i. of intrados cut in detail



($\Delta_4 = d_2 - d_1$)

$d_2 > d_1$ then enlarge panels



intrados panel

geometric compatibility: $f_{left} = f_{right} = f$

then $\boxed{d_2 = d_1 + 2f}$

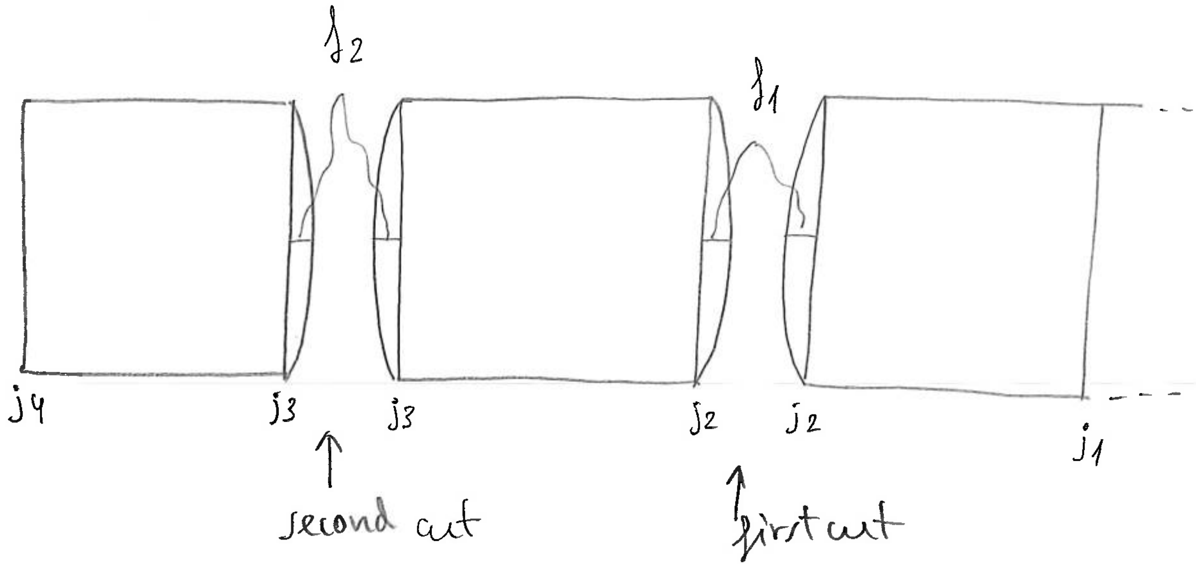
In all cuts, the left and rigth enlargements are the same

NOTE:

$2f = \Delta_4 \rightarrow \boxed{f_3 = k_3 \frac{\Delta_4}{2}}$ compatibility in cut intrados

(see notes about compatibility in first and second cuts)

Compatibility in first and second cuts



$$2f_1 + 2f_2 = \Delta_1 + \Delta_2 + \Delta_3$$

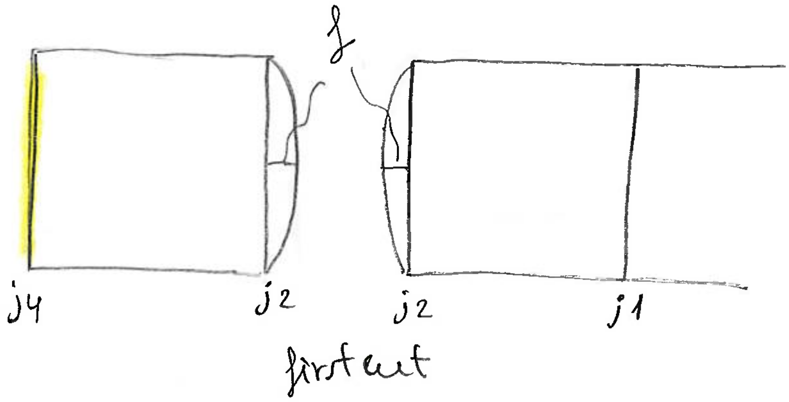
let's define:

$$f_1 = k_1 \frac{1}{4} (\Delta_1 + \Delta_2 + \Delta_3)$$

$$f_2 = k_2 \frac{1}{4} (\Delta_1 + \Delta_2 + \Delta_3)$$

coefficients k_1, k_2 usually 1.0 but the designer may choose other values, such as $k_1 = 0.0$ $k_2 = 0.0$ which eliminates the 3D-shaping. These coefficients control the depth of 3D-shaping!

Case only one cut in extrados



$$2f = \Delta_1 + \Delta 3$$

$$f_1 = k_1 \left(\frac{\Delta_1 + \Delta_3}{2} \right)$$

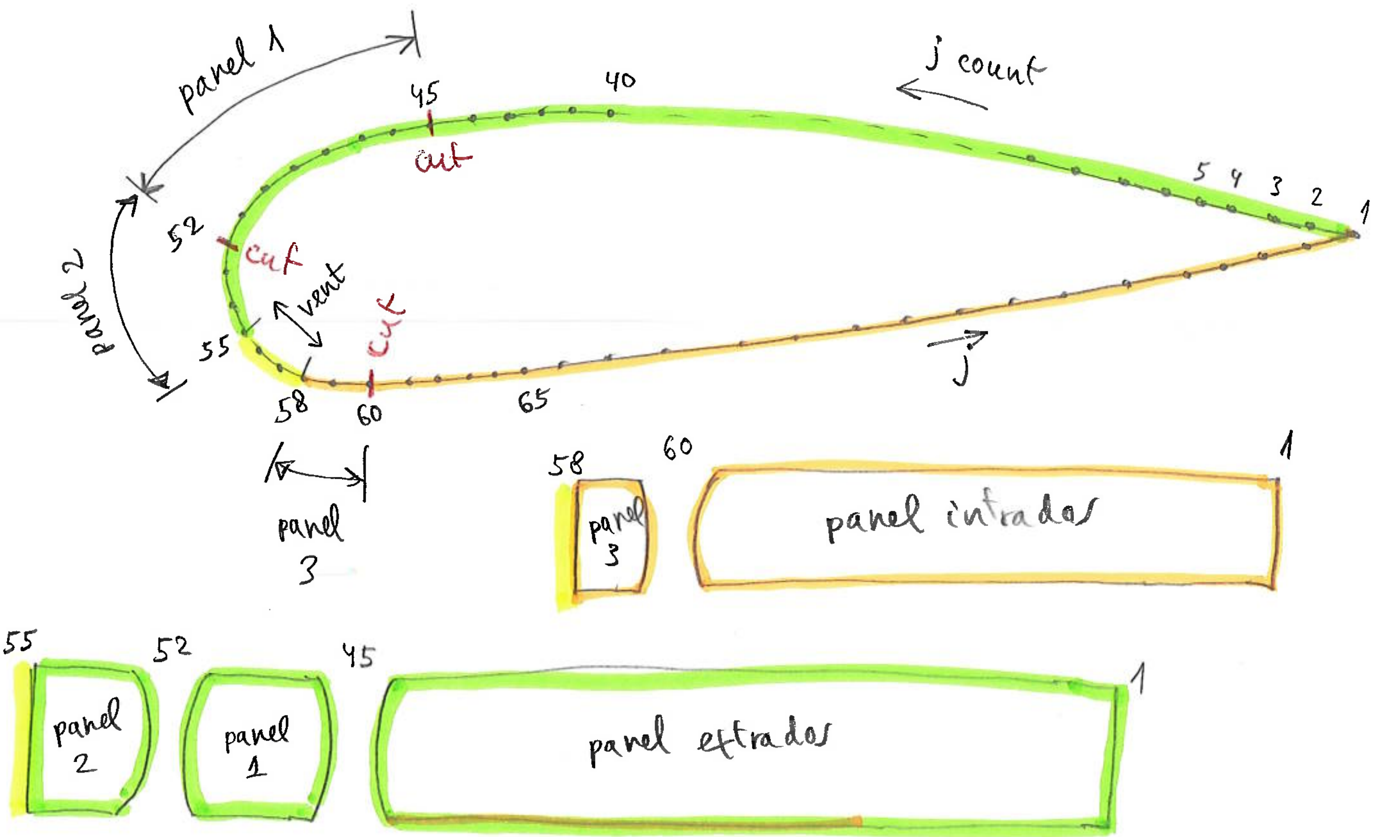
EXAMPLE 1

EXAMPLE 3D SHAPING DATA FILE

```
**********
*  3D SHAPING
***********
1
1  -> type "1"
upper   2    1
1       40   45   1.0
2       45   52   1.0
lower   1    1
1       60   65   1.0
```

(extrados: upper lines; intrados: lower lines)

- 1 → Yes, use 3D-shaping
- upper 2 1 → Use two cuts type "1"
- 1 40 45 1.0 → cut 1 in zone of influence 40 to 45, cut in 45, use k=1.0 depth of effect
- 2 45 52 1.0 → cut 2 in zone 45 to 52, cut in 52 use 1.0 depth
- lower 1 1 → use one cut type "1" in lower surface
- 1 60 65 1.0 → cut 1 in point 60 and area extended to point 65



EXAMPLE 2

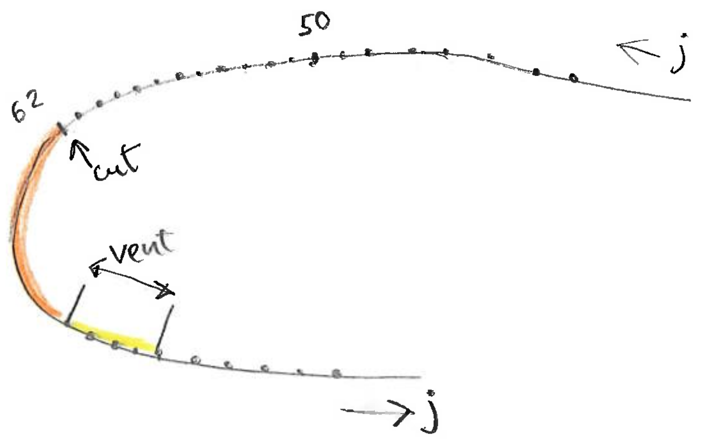
```
* * * * * * * * * * * * *
*  SECTION 29   3D SHAPING
* * * * * * * * * * * * *
0
```

→ Do not use 3D-shaping

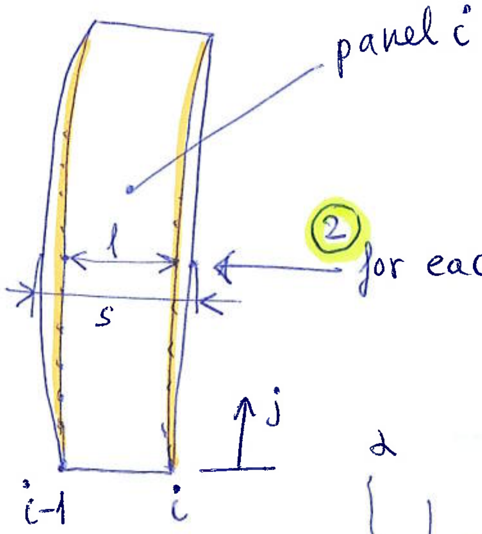
EXAMPLE 3

```
* * * * * * * * * * * * *
*  SECTION 29   3D SHAPING
* * * * * * * * * * * * *
1
1
upper   1   1
1       50   62   1.0
lower   0   1
```

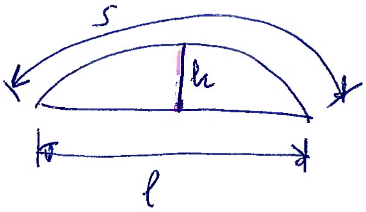
- 1 → Yes, use
- 1 → type "1" (only 1 available)
- upper 1 1 → In upper surface use 1 cut type 1
- 1 50 62 1.0 → cut 1 in z.i. from point 50 to 62, cut in point 62
- lower 0 1 → In lower surface use 0 cuts

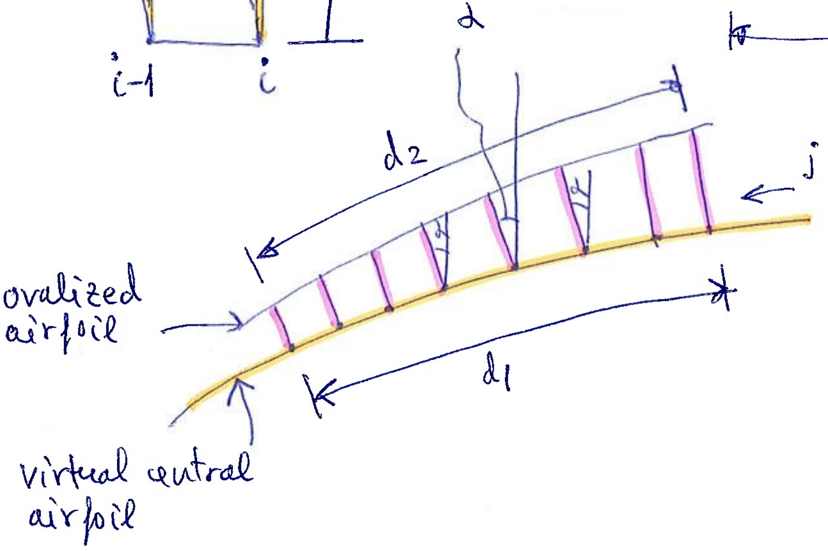


(1) For each rib $i = 1, \ldots, nmaxribs$



(2) for each j compute l, s, h, α



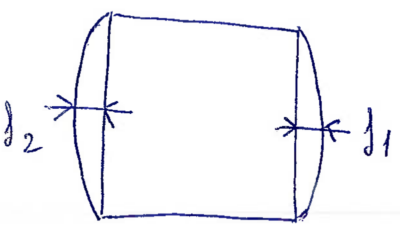


(3) for each cut and zone of influence compute d_1, d_2, Δ

$\Delta = d_2 - d_1$

(4) Assign border enlargement in each cut considering Δ and k (depth of effect)

For each part



(5) Separate and draw all parts
- panel contours
- sewing contours
- reference points
- special marks

(6) Print summary report with the elongation applied to each cut

(7) Generate file with tesellation .dxf and .stl (future implementation), to visualize 3D effects.