CELTIC PIVOTS

B.E SYSTEM

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ABSTRACT

The **Celtic Pivot** is a project initiated and financed by **CNES** (French space agency).

This new product is an improvement of the existing flexural pivots, today mainly this pivot type, whose defects are the following:

- Industrial manufacturing, without fine control, leading to a lack of homogeneity.
- Manufacturer's data (stiffness, behavior under vibration, fatigue) partial and not reliable.

These defects prevent any space application where an excellent reliability is needed.

The Celtic Pivots **have been designed to guarantee an excellent reliability**, and improve the market's pivots performances, and are thus especially dedicated to space applications including systems working in very low temperature (Helium at 4 K)

PRODUCT DESCRIPTION

The **Celtic Pivot** is a flexural pivot. It consists in flat, crossed blades, supporting rotating sleeves, as shown on the figure hereunder:

Obviously, our pivot is supposed to be frictionless, striction-free, with no internal clearance, and only suited for limited angular travel applications, of up to 60° rotation.

It is the only solution for application permitting no lubrication, demanding precise positioning and requiring infinite cycle life.

The **Celtic Pivot** is compact, and can be easily mounted. It has predicable and repeatable performances.

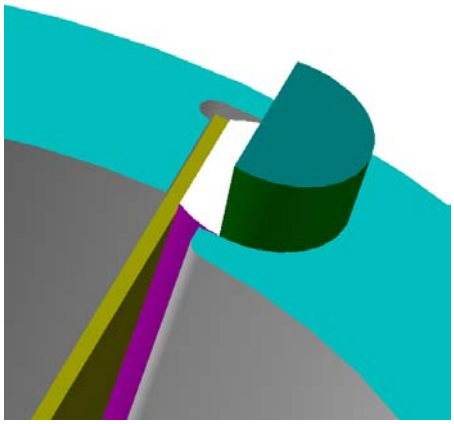
PERFORMANCE CHARACTERISTICS

The main characteristics of the flexural pivots are:

- High radial stiffness
- High axial stiffness
- Friction less
- Stiction free
- No internal clearance
- Low center shift
- No lubrication
- Predicable performance
- Exceptional repeatability

The Celtic Pivot adds some more qualities:
The blades are simply clamped, instead of being welded or brazed.
This allows the use of more performing materials, with better Elastic limit / Young modulus ratio, and thus, lower angular stiffness and increased angular travel possibility.

Moreover, since the blade material characteristics are not deteriorated by the welding, the reliability and the performance predications are highly improved.
In addition our assembly supposes to be reliable even at very low temperatures.
A first generation of "Celtic" pivot was introduced at Toulouse Space Mechanisms Symposium (9/99). But the blades clamping was not reliable after the tests campaign.
BE System designed a new clamping solution (refer to figure hereafter) which is introduced at this symposium and which is under testing.

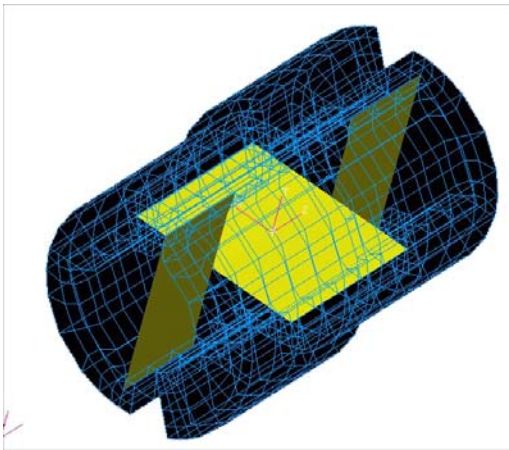


PERFORMANCE VERIFICATION

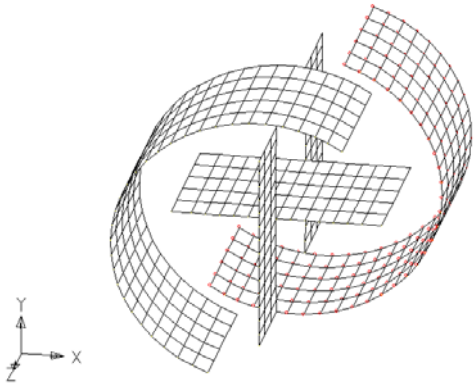
Moreover, FE Models can be used in order to predict new **Celtic Pivots** performances.

FE Models of existing pivots have been correlated to tests results (axial, radial and angular stiffness, maximum allowable forces, ...) and allow to know precisely the safety margins.

The figure hereafter shows the FEM



The figure hereafter shows only the blades, modelized with SHELL elements.



These FEM are fully parametric, allowing any combination of dimension and material.
The output is :
- **angular travel, with safety margin**
- **radial and axial loads, with safety margin**
- **radial and axial stiffnesses**
- **center shift**

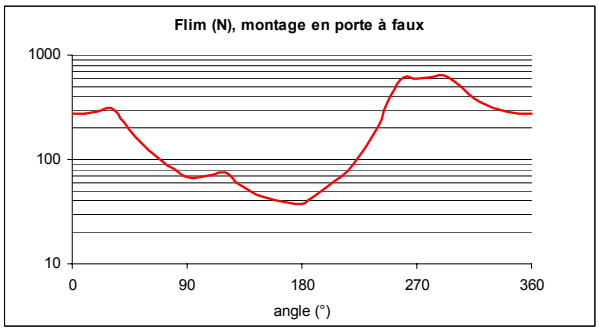
For standard pivots, behavior laws are known and used through spread sheets

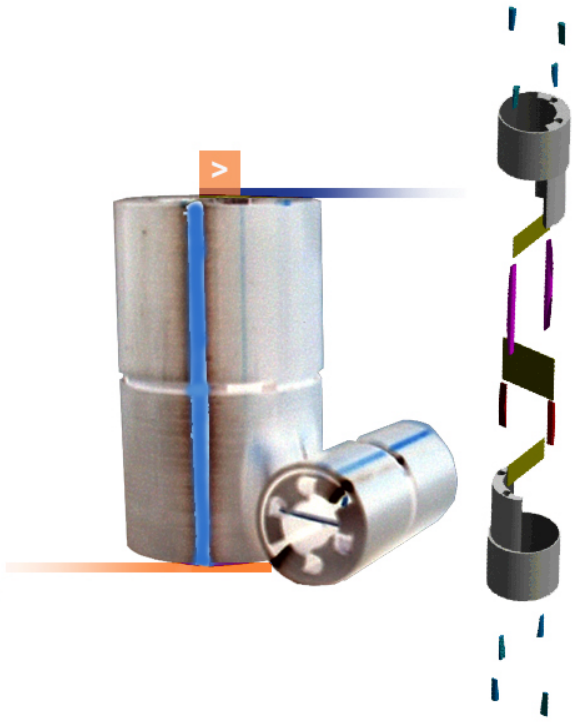
The table hereafter gives some results for **Celtics Pivots** in miscellaneous dimensions (A pivot with Diameter=20 mm, and blade thickness = 0.2mm is called D20e0.2)

Pivot	Max Faxial (in N)	Max Angle (degrees)	Center shift at max angle	Kteta (Nm/rad)
D11e0.1	662	24	0.12	0.04
D11e0.2	1170	12	0.03	0.32
D20e0.1	918	50	*	0.02
D20e0.2	1730	26	0.28	0.23

* angular measures never been used (to important) not reliable center shift analyses.

The figure hereafter shows the admissible radial force evolution for a pivot D11e0.1.





CONCLUSION

2 kind of **Celtic Pivots** already exist and are under testing

- Inox sleeves and CuBe3 blades
- Φ11mm, blades thickness: 0.2mm
- Φ20mm, blades thickness: 0.2mm

But the Celtic Pivot allows many combinations of sleeves and blades:

Sleeves: Any external shapes and sizes (over 11mm diameter), any material.
Blades: any thickness between 0.1mm to 0.5mm, and any materials like CuBe3, inox, titan,…

Moreover, special pivots can be made on demand, with specified material, performance and interfaces.