DYNAMIC SIMULATION OF A PACKAGING MACHINE FOR BLOCKS OF ALLUMINIUM.

Written by Ing. G. Soregaroli Cosmos Italia Srl.

The present document is a practical example of how to use and apply Dynamic Designer Motion (DDM) to a realistic case of the main Italian producer of semifinished aluminium.
The DDM version used is the 3.0 for the solid modeler Solid Works 2000.

The realization of a structure according to the sizes and performances specified by the final user asks for a complete project that includes the definition of the geometries, the study of the dynamic behaviour and the structural calculation of the most stressed components.

'Design Analysis' tools offer a complete solution to this problematic thanks to a CAD CAE integrated solution that adds an astonishing user friendliness to the power of traditional solvers. In particular, Dynamic Designer Motion (DDM) (RIF. 1) for SolidWorks (RIF .2) allows to solve in a complete and intuitive way, kinematic and dynamic problems of mechanical design.

The geometric model of the whole packaging machine is represented in Fig. 1.
The working cycle of the machine is established from the following functions: loading, alignment, packaging, and unloading.
The loading of the machine is performed through a rolling device that transports the blocks of aluminium to the working zone; the correct position and alignment is carried out by means of frontal leveling (FIG. 2) and (FIG. 3).
After alignment process has been completed, the actual packaging phase has to be performed. During this step it is necessary to transfer to the blocks the correct force in such way that when clamping is performed it is done without permanent deformation. The final product constitutes eight packaged blocks of aluminium that, once they are released by the presser, they become unloaded from the level where they are then moved away from the working zone.
This paper focuses on the packaging phase in which, through the use of a jack, it supplies a part of mechanism(FIG. 4), the necessary force that guarantees the correct position for the blocks.
The working cycle of the mechanism is composed of three phases, the extension of the kinematic chain, the impact between the blade and the profiles of aluminium and the returning to the starting position.

The main point of the paper is the definition of the geometry of the mechanism. Such mechanism must guarantee at least a 1:2 ratio between applied force and force result.

The motor of the kinetic chain is a hydraulic actuator that when it is at rest it is seen at a vertical position. The head of the actuator-piston is connected to a mobile pin in which there

are connected four conrods of the same size: two of which are connected to the base through a fixed pin representing the principle kinetic "ground" support. The other two are instead hinged to the pressing pin.
The final part of the mechanism is made up of a pin and a blade that connected between them are three links that slide on the inside of the appropriate guides, driving the blade horizontally towards the profiles.
At the start the hydraulic cylinder is in a vertical position and the conrods are placed in an upturned "V". During the horizontal transfer of the end of the mechanism there must be a certain force that when vertical excessive loading occurs it does not bend the driving and cause permanent deformation to the cylinder.

The logic flux of data, used during the phase of design (Fig.5), promises to have a greater knowledge of the functional characteristics and of the performances of the machine.

The 3D geometries have been defined by the solid modeller SolidWorks. The purpose of the parts well-established, can be considered an essential definition, that is, representing the better mass and the stiffness in study, but without details of the parts.

The great integration of Dynamic Designer Motion in Solidworks allows it to translate assembly constraints into kinematic constraints, using "Ground Parts" and "Moving Parts".
It is said that "Ground Parts" tends to indicate that the kinematic parts cannot be moved, instead with "Moving Parts" movement can be undergone.

For friction definition there are two necessary parameters, the superficial area of equivalent contact, inserted by diameter and width, and the friction coefficients as shown in Fig. 7.
With the completion of the model study, added is phenomenon impact with some appropriate conditions and parameters: Stiffness, length, max damping, exponent and penetration.

In this paper there are two kinds of analysis: the first to calculate the strength and the time of entry of the piston and the other to calculate the moments of impact. For the first calculation the function STEP has been used. The movement of the piston is compounded by the lengthening, from its persistence of certain moments to the maximum elongation and the return to the starting position.
From the force diagrams, necessary to make movement happen, there are data proceeds for subsequent analising.

The force is first slow then during the compact of the profiles it increases, finally, it decreases to its initial value.

Simulating the behaviour of the cycle the analysis of the machine lasts up to 5 sec. During these 5 sec. 200 steps have been used. (Fig 8)

Studying the results of the preliminarily kinematic analysis, the geometrics are modified, to obtain the best results. The integration of DDM allows the possibility to modify the geometry of the mechanism and to reconstruct automatically.(Fig. 9)

At last, to conclude the planning cycle, the force and the moments effective on all parts, are translated onto COSMOSWork codes (Rif.3) completed integrated in Solidworks.
With COSMOSWorks, stress of the mechanism parts can be calculated as shown in Fig. 10.

1- Dynamic Designer Motion - User's Guide
2- SolidWorks - User's Guide.
3- CosmosWorks Manuals

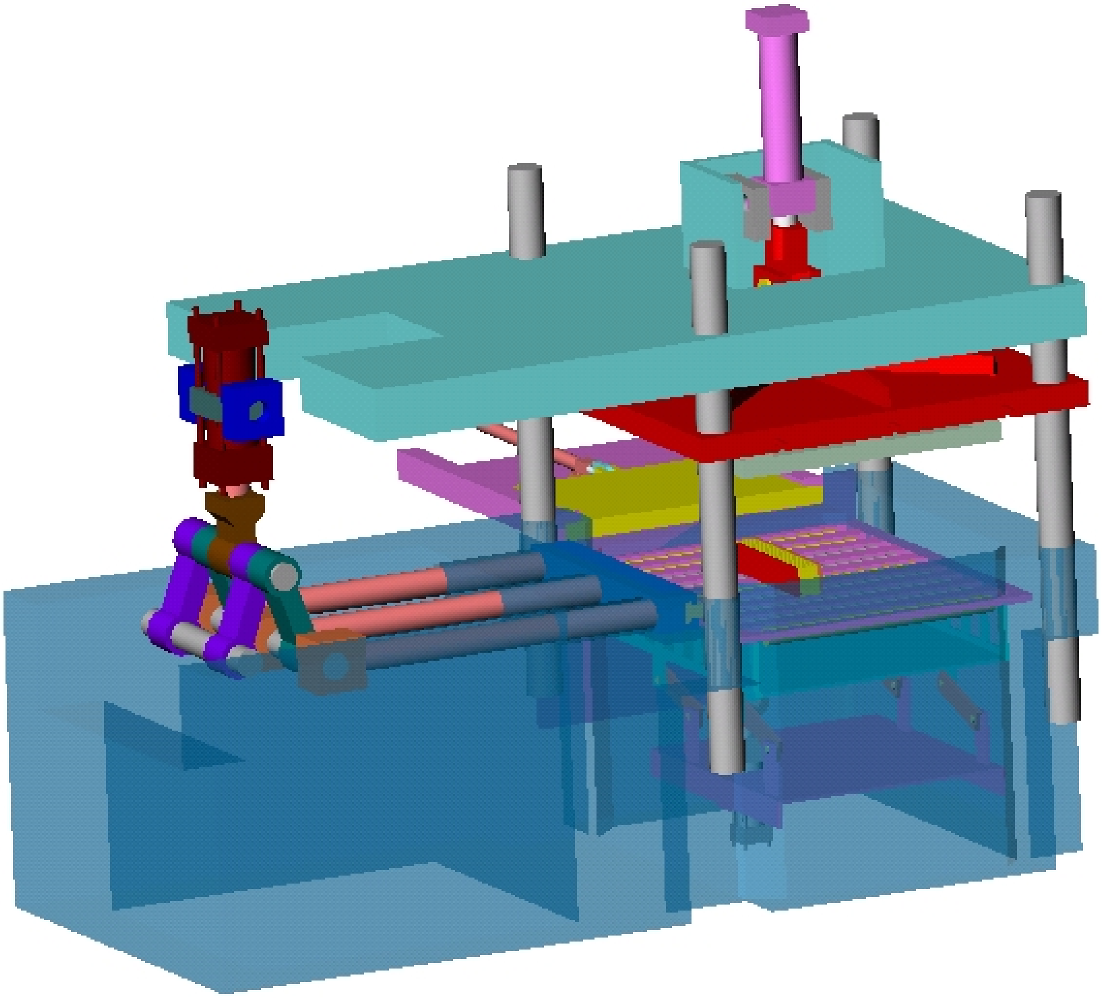


Fig. 1

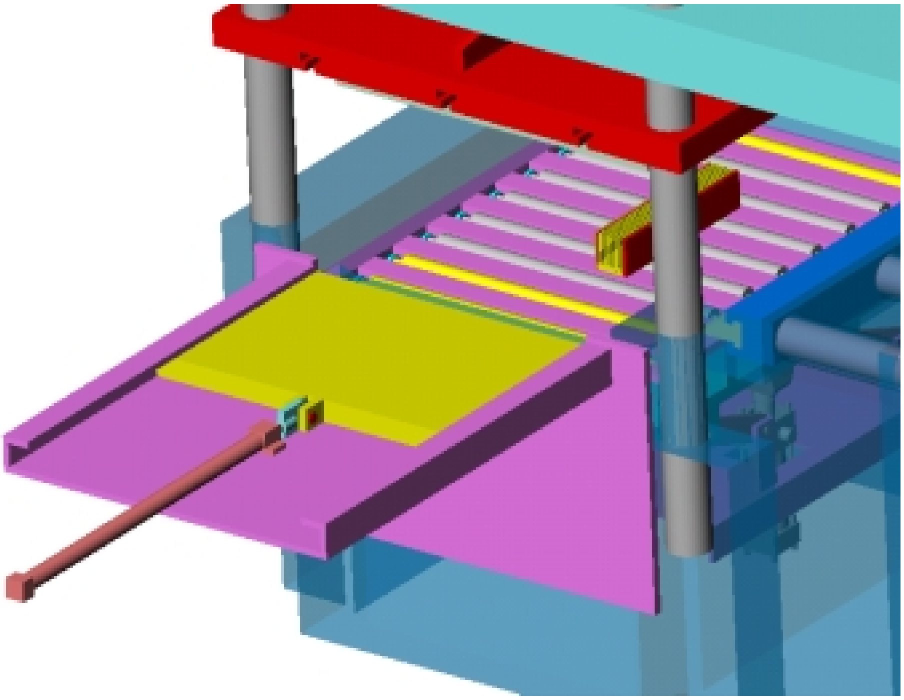


Fig. 2

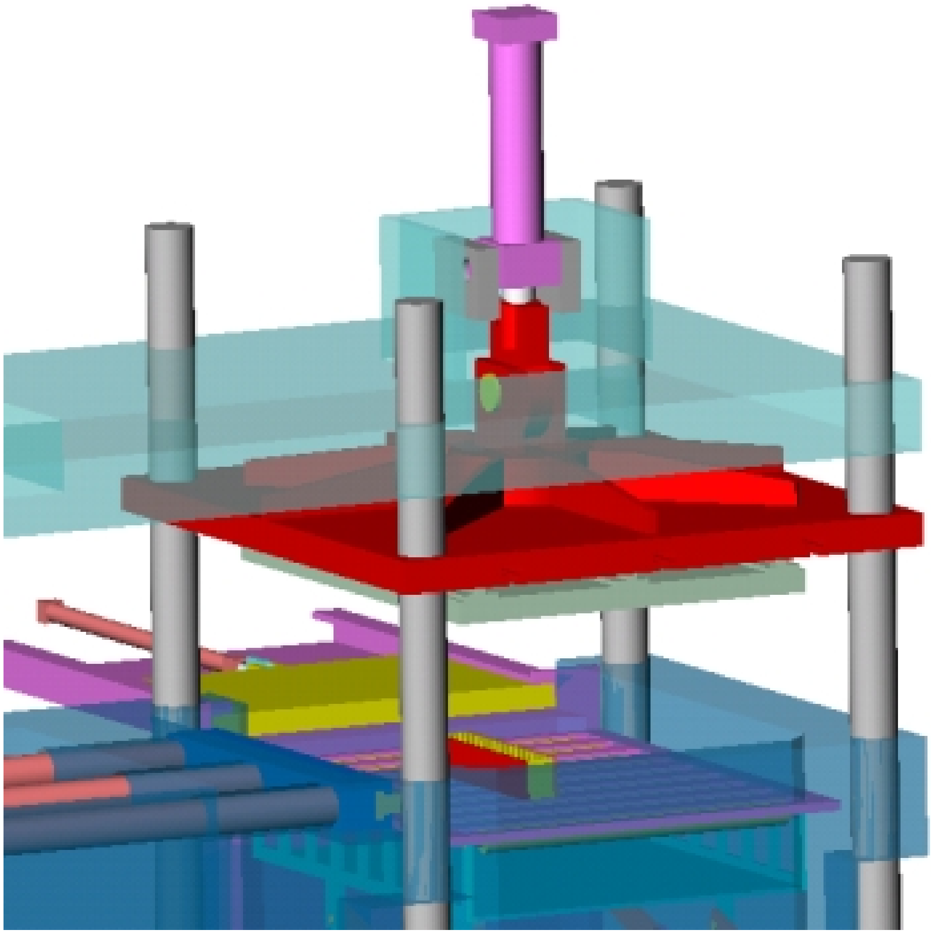


Fig. 3

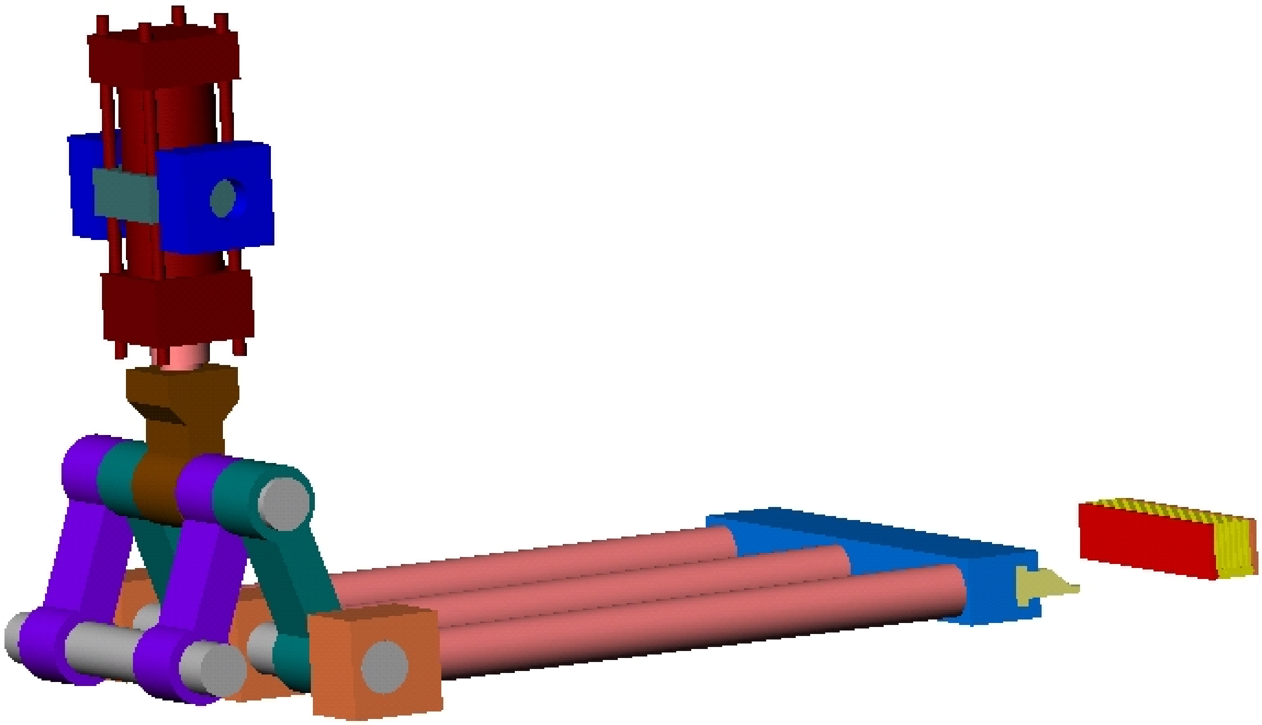


Fig. 4

Fig. 5

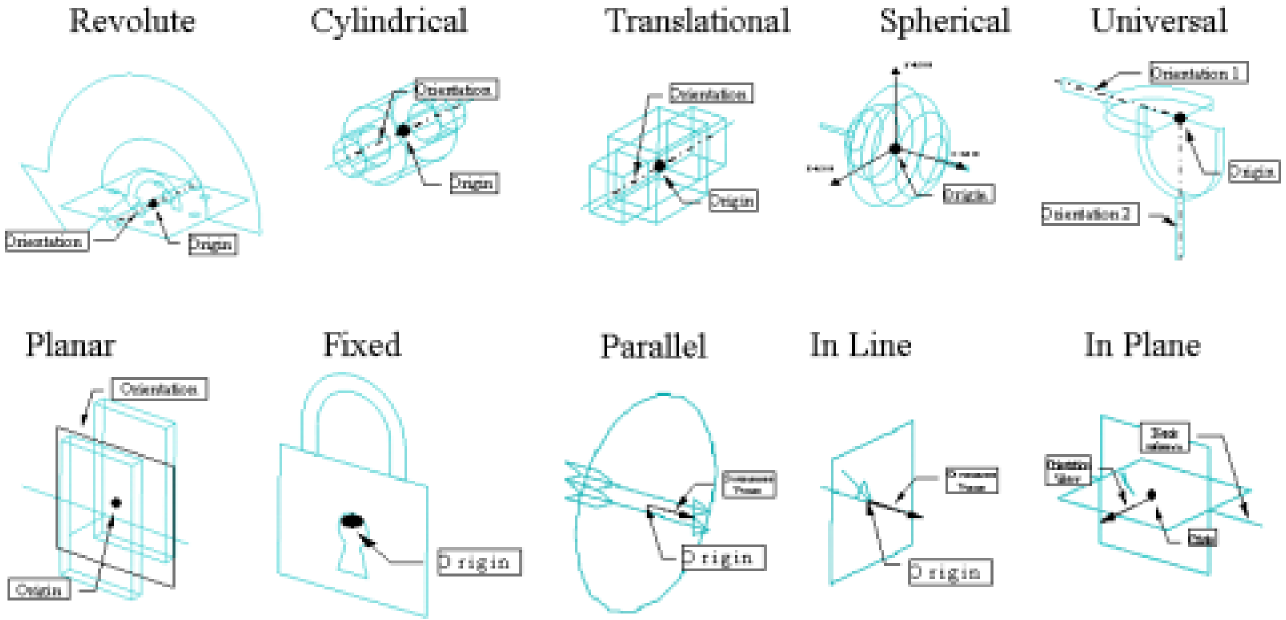
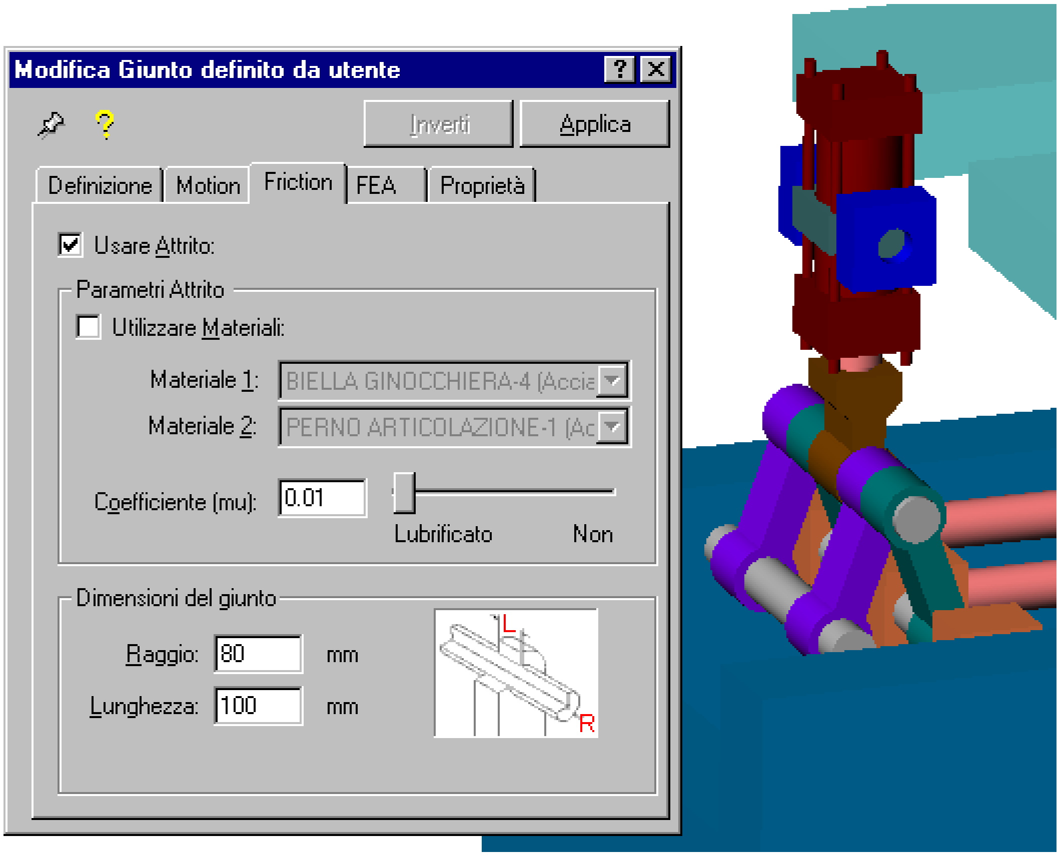


Fig. 6



Modifica Giunto definito da utente

☑ Usare Attrito:

Parametri Attrito

☐ Utilizzare Materiali:

Materiale 1: BIELLA GINOCCHIERA-4 (Accia

Materiale 2: PERNO ARTICOLAZIONE-1 (Ac

Coefficiente (mu): 0.01

Dimensioni del giunto

Raggio: 80 mm

Lunghezza: 100 mm

Fig. 7

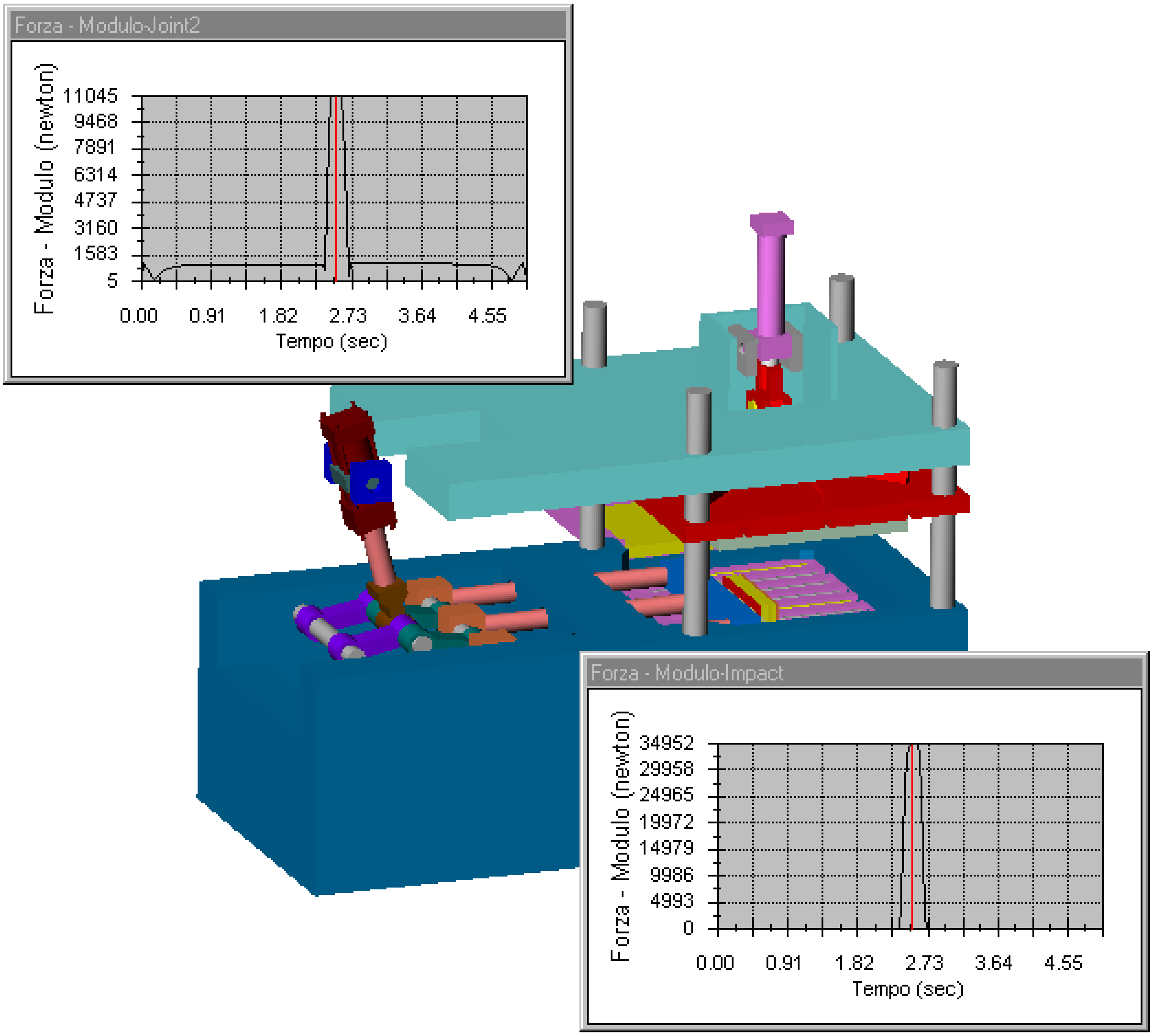

Forza - Modulo-Joint2
Forza - Modulo (newton)
11045
9468
7891
6314
4737
3160
1583
5
0.00
0.91
1.82
2.73
3.64
4.55
Tempo (sec)
Forza - Modulo-Impact
Forza - Modulo (newton)
34952
29958
24965
19972
14979
9986
4993
0
0.00
0.91
1.82
2.73
3.64
4.55
Tempo (sec)

Fig. 8

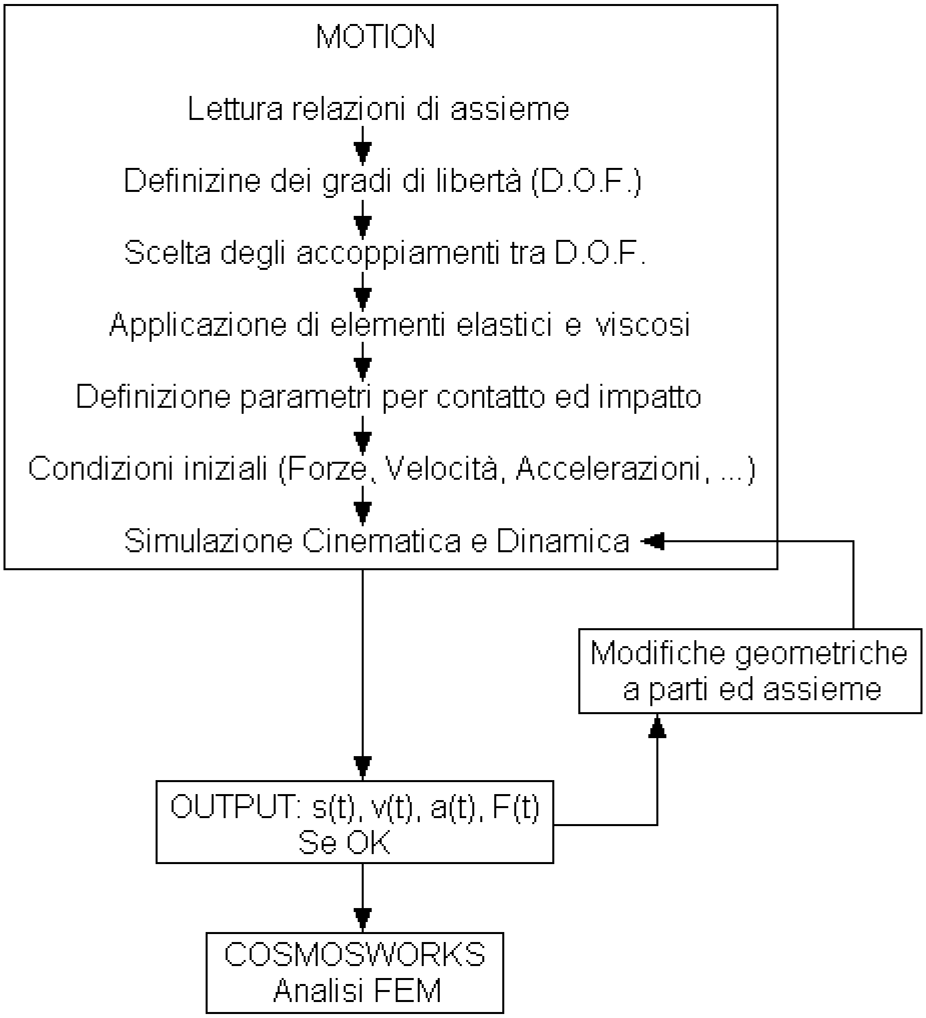

MOTION
Lettura relazioni di assieme
Definizine dei gradi di libertà (D.O.F.)
Scelta degli accoppiamenti tra D.O.F.
Applicazione di elementi elastici e viscosi
Definizione parametri per contatto ed impatto
Condizioni iniziali (Forze, Velocità, Accelerazioni, ...)
Simulazione Cinematica e Dinamica
Modifiche geometriche a parti ed assieme
OUTPUT: s(t), v(t), a(t), F(t) Se OK
COSMOSWORKS Analisi FEM

Fig. 9

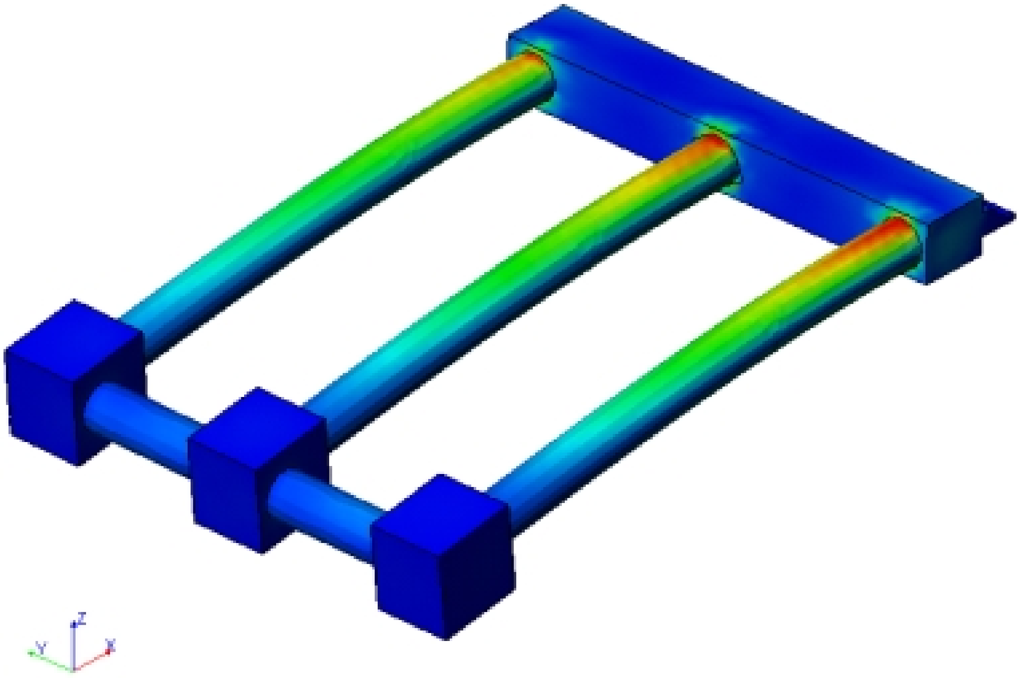

Z
Y
X

Fig. 10