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UP AND DOWN CAR MECHANISM DYNAMIC SIMULATION

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ABSTRACT:
In this paper the authors presents up and down car mechanism dynamic simulation with Autodesk Inventor Professional program. By determining 3D model it will be created and tested a complete virtual prototype of the mechanism, in real exploitation conditions. By dynamic simulation it will be verifying kinematic assembly in real conditions of function and load, respectively design validation.

KEYWORDS:
Mechanism, gear, prototype, parametric model, finite element analysis

1. INTRODUCTION

In the same time with car industries evolution, as well as technical performances are increased, also are developing engines, gears, aerodynamic bodies, board computer, or passive safety elements, the car producers insist very much on driver comfort, respectively on ergonomic binnacle.

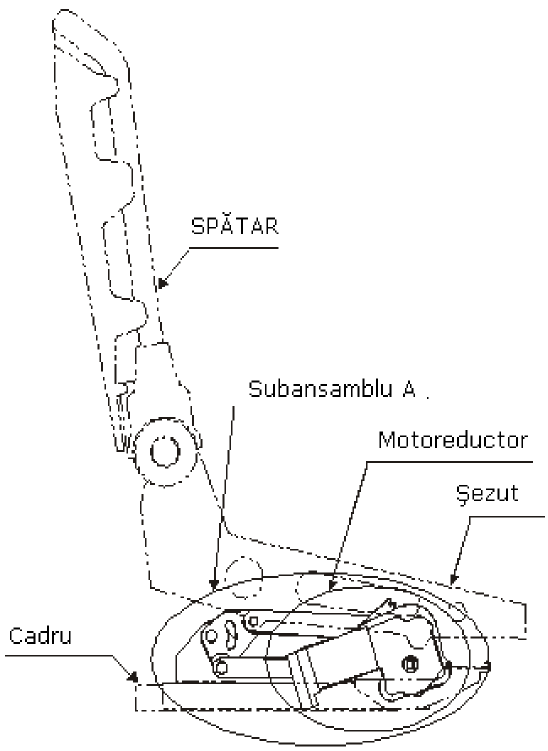

FIGURE 1. MECHANISM SUBSYSTEMS

The elements who define the driver comfort respectively ergonomic binnacle are: driver seat comfortable positioning (on vertical and horizontal plane) with minimum effort, for example through a button; heated seats; car control buttons on the wheel.

Up and down mechanism is conceived and is adjustable to driver seat function on seat dimension.

In proportion with driver seat dimension, up and down mechanism is composed by the following subsystems (figure 1).

- electric engine – reducing gear who engage up and down seat mechanism (is in bond with subsystem A)
- *Subsystem A*, in right side of the seat, is composed by a cylindrical gear rail and a plane mechanism with bars
- *Subsystem B*, in the left side of the seat, composed by a plane mechanism with bars identical with the subsystem A (hidden in figure 1)

Subsystem A kinematic scheme is presented in figure 2.

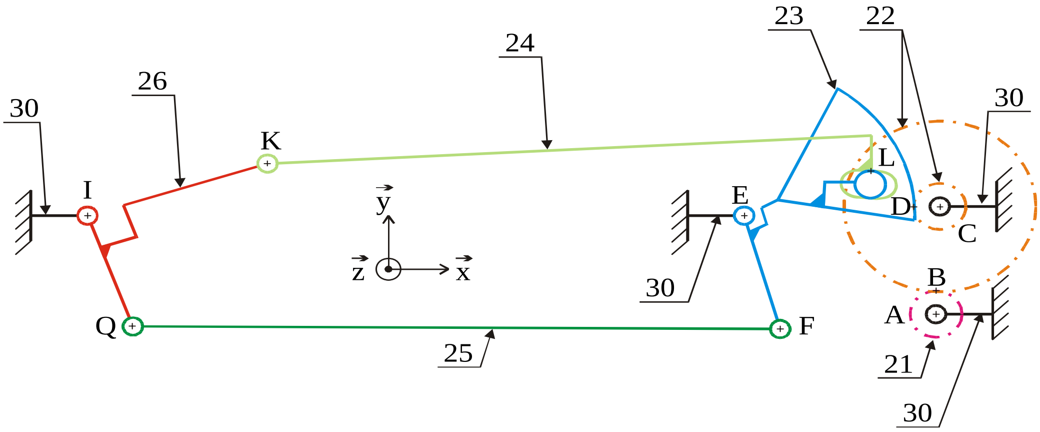

FIGURE 2. SUBSYSTEM A KINEMATIC SCHEME

Cylindrical gear has the entire rotational axis fixed. The pinion (21) is taken the rotational move from worm gear (17), and will transmit to gear from subsystem (22). The pinion from subsystem (22) engages with the gear sector (23) that is in fact the crank of up and down plane mechanism of the seat. The motion is transferred through mechanism kinematic elements, connecting rod (25) and balancer (26), to connecting rod who carry the seat (24).

2. MECHANISM 3D MODELLING AND DYNAMIC SIMULATION

Designing and geometric dimensions obtaining for plan mechanism and gear pears was obtained according to recommendations from mechanisms and machines theory based on de following input dates:

- *The power of electric engine: 55 W*
- *The speed of electric engine: 3000 rot/min*
- *Up and down stroke of the seat – h = 38 mm*
- *Time to lift up the seat – t = 3,1 s*
- *Driver and mechanism weight – m = 120 kg*

Up and down seat mechanism kinematic elements (joint bars, gears) were modeled in Autodesk Inventor program.

The modeled component pieces are assembled with 3D constrained. Assembly constraints selection is very important. Next, it was verified the up and down kinematic driver seat mechanism and component pieces interferences; the authors wants to realize a fast dynamic simulation prototyping. It was chosen mate type constraints, to suggest rotational kinematic pairs generating through mechanism kinematic elements. Up and down car seat mechanism 3D model is presented in figure 3.

For dynamic simulation and fast prototype, it was considered an up and down mechanism simplified: it was canceled the first level of worm and cylindrical gear, from reducing gear. Simplified models mechanisms in the two extreme positions are presented in figure 4.

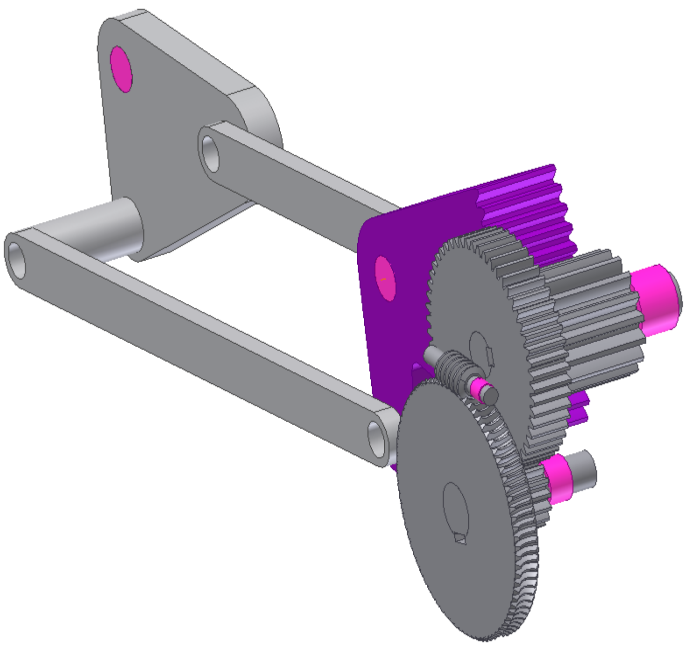

FIGURE 3. UP AND DOWN MECHANISM 3D MODEL

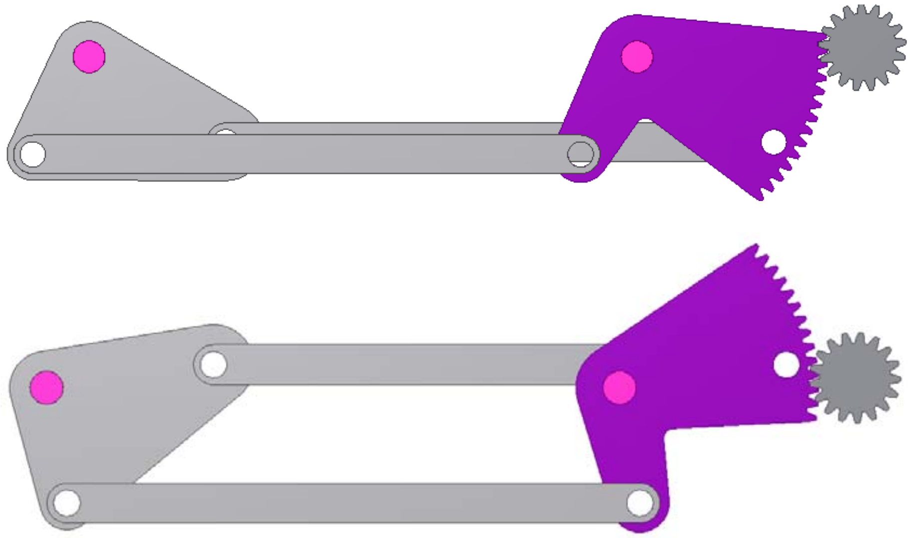

FIGURE 4. THE EXTREME POSITIONS FOR SIMPLIFIED MECHANISM

Dynamic simulation was realized with the following steps:

- Defining the kinematic pairs:

Up and down mechanism kinematic pairs can be defined by automatic or manual assembly constraints conversion. In figure 5 is presented rotational kinematic pair definition between the fixed element and the gear sector by manual conversion. The other kinematic pairs will be defined in the same way.

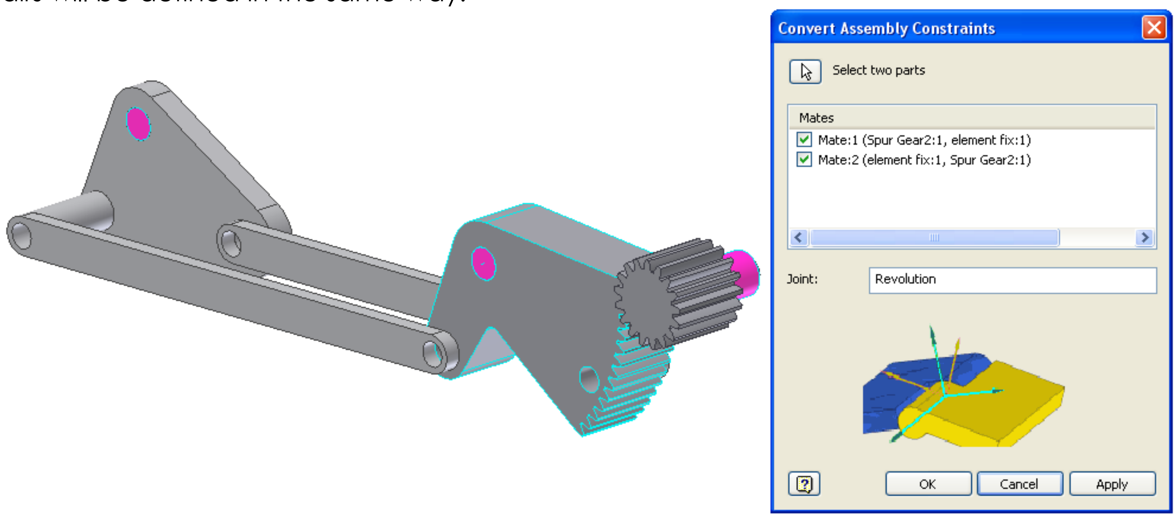

FIGURE 5. ROTATIONAL KINEMATIC PAIR DEFINITION

- Defining the *input motion* for driving gear. In rotational pair (fix element - pinion) was defined a rotational motion, by defining rotational angle, rotational velocity and driving moment, the values were obtained from design calculations.
- Defining the mechanism loads – net weight and loads according to the design subject.
- Results after simulation

After the mechanism simulation (execute a kinematic cycle, respectively lifting up the seat), with *Output Grapher* option, was obtained kinematic and kinetostatic values time variations for kinematic pairs, in real conditions of exploitation (positions, velocities, accelerations, forces and moment of reaction).

For example, in figure 6 is presented contact force variation (reaction) in kinematic pair between the pinion and gear sector.

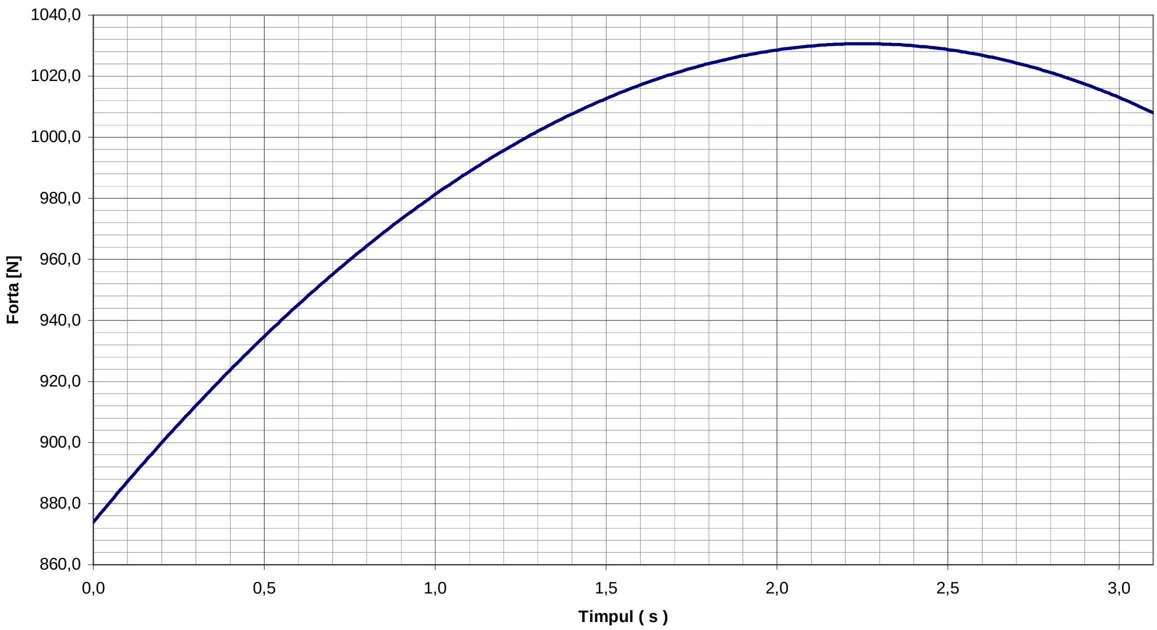

FIGURE 6. CONTACT FORCE VARIATION

3. FINITE ELEMENT METHOD ANALYSIS

Dynamic simulation module from Autodesk Inventor Professional 2008 program, allow mechanism components finite element method analysis, in different moments on kinematic cycle.

Gear sector stress analysis with Autodesk Inventor Professional was made in the same time with mechanism dynamic simulation, with existing loads for a kinematic cycle.

For finite element method analysis it was chosen a gear sector on time t=2,25s, where contact force is maximum according to figure 6.

After gear sector finite element method analysis was generate a results report. For example, in figure 7 is presented equivalent stress in the moment of analysis.

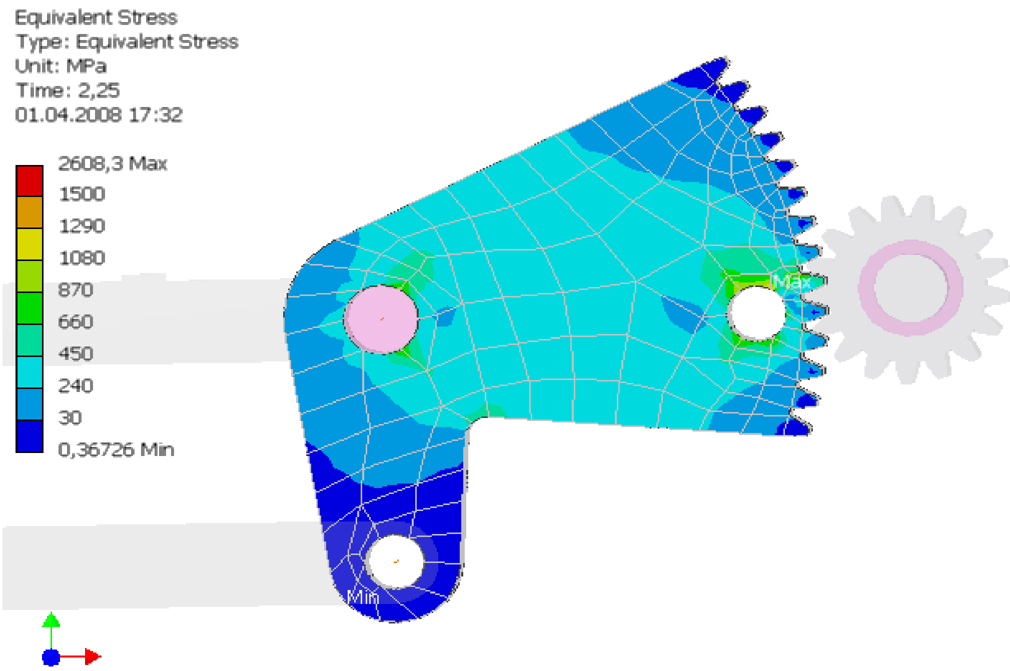

FIGURE 7. EQUIVALENT STRESS ON TIME t=2,25s

4. CONCLUSIONS

For a product to make a market launch is necessary to testing the product and realize prototypes that are very expensive and time consumption. By realizing up and down mechanism 3D model in Autodesk Inventor, it was created and tested a complete virtual prototype in real conditions of exploitation. It was verified that the pieces to be correctly in assembly and was detected interferences and other errors of the model. Through product dynamic simulation it was verified assembly kinematics in real conditions of work and load. During mechanism work simulation, was assure design validation and was avoid real prototype realization.

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