

THE STUDY OF THEORETICAL PROBLEMS RELATED TO THE MILITARY EQUIPEMENT AND TECHNOLOGIES WITH THE HELP OF COMPUTER ASSISTED GRAPHICS

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Abstract: The article exemplifies some of the applications of the CAD concept in the study of the fundamental technical subjects, which precedes the study of the specialty subjects in military aviation equipment and technologies: double orthogonal projection and solid modeling, revolution bodies, mass properties, animated representation techniques, graphical methods for the cinematic study of the link rod mechanisms.

Keywords: orthogonal projection, animated representation, flanges, bushes, sleeves, shafts, lids.

1. THE PRINCIPLE OF THE FIRST AND THIRD ANGLE ORTHOGRAPHIC PROJECTION

The normal positioning of projections can be easily and evocatively acquired by using the solid modeling of polyhedrons. Fig. 1 illustrates a realistic image of a prism with a series of chamfers, channels and orifices.

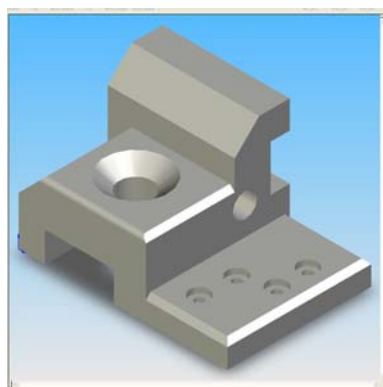


Fig. 1 The analyzed theoretic model

The terms specific to solid modeling technique were imposed by the emergence of the specialized programs for this purpose. Therefore, they do not always have an analogous term in Romanian. For instance, the widely used term *feature* is translated as *characteristic* even though it also denotes a

certain operation and a particular element. For example, an extrusion, by comparison with the technological process that bears the same name, could be the very process through which a sketch is transformed into a solid. Also, the same extrusion can be the basic characteristic of a complex solid. Finally, extrusion can be considered a tool as well, i.e. a solidification tool.

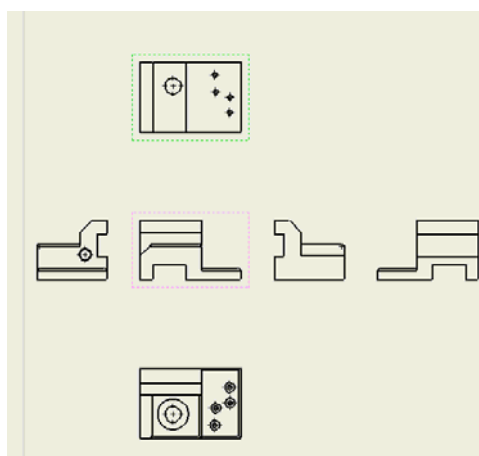


Fig. 2 Principle of angle orthographic

In other words, according to the English terminology of solid modeling, the instrument, the process and the modeled element are sometimes referred to by using the same term.

The terms first and third angle correspond to the notation used in mathematics for the

quadrants of a circle. In Fig. 2, the body represented in Fig. 1 is considered as placed inside an imaginary cube, projected onto the cube's interior faces, after which the latter are displayed in one of the two possible modes. Thus, the two possible modes of the projections' normal positioning are obtained, also known as method A and method E.

Perhaps the most significant common denominator of all the solid modeling programs is the "active plane" or work plane (WP). Any sketch necessary to its subsequent solidification by means of a particular process, is a plane sketch, i.e. it belongs to a plane. It is composed of a series of elementary geometrical elements, interconnected in a specific sequence (to a line, point, arc or to another plane, curve, polygon, etc.), which can only be performed in a plane. And this plane is called an active plane, which is specifically selected at the beginning of the sketching, unless the program itself prompts for the plane to be defined. An active plane can be any of the three rectangular planes (two by two in a perpendicular position) of the universal Cartesian system, called horizontal, vertical, and lateral, or any other plane defined in relation to other characteristic elements of the model. It can be defined by means of three points, a line (possibly an edge of the model) and a point, by moving with an appropriate distance one of the three planes of the trihedral, by slanting an existent plane; practically, there are numerous ways of conveniently defining a current WP. The easiness and rapidness of building the model depend on appropriately choosing this plane. As far as the modeling is concerned, this is somewhat similar, for instance, to choosing the UCS coordinate system from AutoCAD. Once this active plane is selected, in some programs, either a window is opened, "materializing" this active plane in which it is carried out the sketching precisely in the plane in which the drawer works, i.e. the plane of the screen; or the representation plane becomes an active plane in a direct manner. Once the active plane established, all the instruments and means of plane representation become accessible, including the intelligent methods of notation, geometrical restrictions (parallelism,

perpendicularity, etc.), or objectsnap (smartdimension, intelisketch, objectsnap, etc.).

2. ANIMATED REPRESENTATION TECHNIQUES

The landing gear mechanisms that are studied as part of the specialty discipline are built in a large variety of types, motions, cinematic couples, etc. that will not be covered in the present article. We will only refer to their way of representation, and the analysis and animation of the representation.

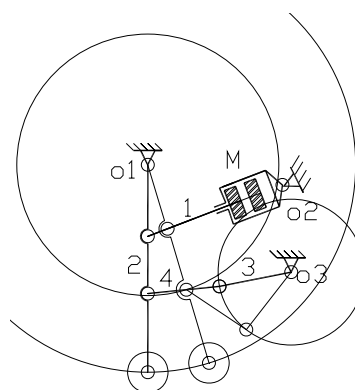


Fig. 3 Cinematic scheme of the landing gear mechanism

One way to create the animated representation of the mechanism's functioning is to obtain individually one position at a time by choosing a motion parameter, for example the distance of the hydraulic cylinder piston of the leading element, followed by the introduction of the successive positions in a suitable graphic environment, such as Macromedia Flash. In order to correctly obtain the successive positions (and to accurately keep the distances and angles), the AutoLISP application was built, here called "aatren" and presented below.

```
(DEFUN C:aatren ( )
(SETQ d (GETREAL "Valoarea cursei d:")
o1 (list 300 500)
o2 (list 1000 500)
o3 (list 1000 250)
r 200
r1 300
r2 300
d1 (distance o1 o2)
a (/ (- (+ (expt d1 2) (expt d 2)) (expt r 2))) (* 2 d1
d))
```

```

b (sqrt (- 1 (expt a 2)))
c (/ b a)
u (atan c)
p1 (polar o2 (+ pi u) d)
  u1 (angle o1 p1)
  p2 (polar o1 u1 400)
  p3 (polar o1 u1 600)
  p4 (polar p1 u 1000)
  c1 (polar p4 (+ (* (/ pi 180) 30) u)
40);pistonulc1c2c3c4
c2 (polar p4 (+ (* (/ pi 180) 150) u) 40)
c3 (polar p4 (+ (* (/ pi 180) 210) u) 40)
c4 (polar p4 (+ (* (/ pi 180) 330) u) 40)
i1 (polar o2 (+ (/ pi 2) u) 40);cilindruli1i2i3i4
i2 (polar o2 (- u (/ pi 2)) 40)
i3 (polar i1 u 500)
i4 (polar i2 u 500)
d11 (distance p2 o3)
a11 (/ (- (+ (expt d11 2) (expt r2 2)) (expt r1 2)) (*
2 d11 r2 ));elem3si4
b11 (sqrt (- 1 (expt a11 2)))
c11 (/ b11 a11)
u11 (atan c11)
u12 (angle p2 o3)
u13 (+ u11 u12)
p11 (polar o3 (+ pi u13) r2)
    )
    
```

In this example, for the constructive elements of the cinematic chain, the following values were selected: a 200-unit ray r (from O_1 to the first articulation of the chain), the rays r_1 and r_2 of the rod systems each of 300 units, a 1000-unit long hydraulic engine piston's rod ($p4$ (polar $p1$ u 1000)), and a 600-unit distance from O_1 to the second articulation ($p3$ (polar $o1$ $u1$ 600)). All these can be easily modified, depending on a particular situation.

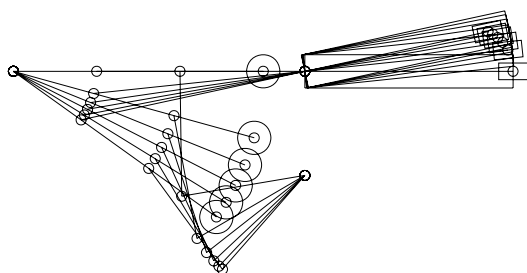


Fig. 4 The succession of the mechanism elements' positions, with a 10-unit distance of the piston's movement, from $d = 500$ to $d = 550$, as obtained with the use of the "aatren" application

The above illustrated application does not include the AutoCAD commands for drawing

as well, only the instruments for assigning the variable's values that are of interest in the animated representation of the cinematic sketch.

3. GRAPHICAL METHODS WITH CAD INSTRUMENTS

Let there be the cinematic sketch of the known mechanism in figure 1. The vectors corresponding to the speeds of the points $p1$ and $p3$, marked as such to better observe the presence of the coordinates of these points within the application that will be further presented, have been attached to the current position.

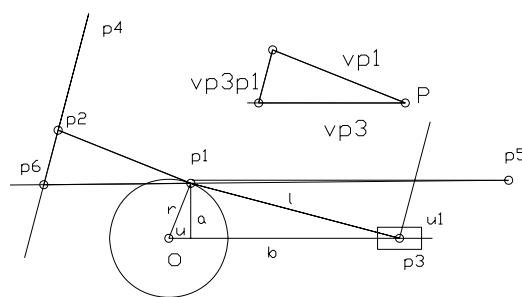


Fig 5 Cinematic sketch of the mechanism and the attached plane of the speeds

In figure 5, the plane of the speeds was represented for the current position first with the pole to the plane in point $p2$ of the mechanism, and then, for clarity reasons, with the pole in point P . For any position of the elements, the speeds' polygon follows the vector relation:

$$V_{p3} = V_{p1} + V_{p3p1} \quad (1)$$

The next application, called "biela", illustrates the automatic representation of the edges of the speeds' polygon and returns the value of the distance between $p1$ and $p6$, which is precisely the instantaneous speed of the driven element. It requires to manually insert (using the keyboard) the current angle u , the ray r , the revolution n , and the length of the rod l .

```

(DEFUN C:biela ( )
(SETQ u (GETANGLE "Valoarea unghiului u:")
r (GETDIST "Valoarea razei r:")
n (GETREAL "Valoarea turatiei:")
p1 (polar o u r)
    )
    
```

```

l (GETDIST "Lungimea bielei l:")
p2 (polar p1 (+(/ pi 2) u) (/(* pi 2 r n) 1000))
a (* (sin(/ (* u pi) 180)) r)
b (sqrt (- (expt l 2) (expt a 2)))
p3 (polar o 0 (+ b (* r (cos (/ (* u pi) 180))))))
u1 (- (angle p1 p3) (/ pi 2))
p4 (polar p2 u1 100)
p5 (polar p1 0 200)
p6 (inters p1 p5 p2 p4 nil)
(Command "Point" p1)
(Command "Point" p2)
(Command "Point" p6)
(Command "Pline" p1 p6 "c")
!(distance p1 p6)
)

```

For instance, for an angle of 60 degrees, a ray of 200, a revolution of 800 rotations / minute, and a length of 300, the program returns:

```

Command: biela
Valoarea unghiului u:60
Valoarea razei r:200
Valoarea turatiei:800
Lungimea bielei l:300
1088.31.

```

Similarly, a cinematic study can be carried out, as well as and an animation of its functioning for the mechanism with sway bar link, another well known mechanism. The previously mentioned method, for the rod mechanism, can be generalized for any other type of mechanism with joint bars, plane-parallel moving parts, or even such specific mechanisms as the landing gear.

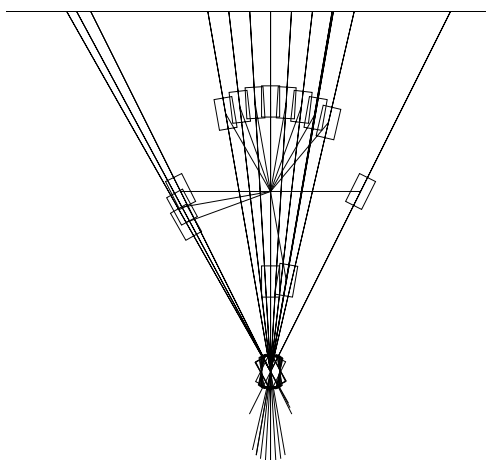


Fig. 6 Successive positions of the sway bar link mechanism's elements

Figure 6 illustrates a few successive positions of the elements of a sway bar link mechanism as obtained with AutoCAD, and with the help of the AutoLISP application, which preserves the construction values of the mechanism's elements and requires the repetitive insertion of the current value of the leading element's angle u , selected as a movement parameter. Next, this application (called "aaculisa") is presented.

```

(DEFUN C:aaculisa ( )
(SETQ o1 (list 1000 600)
o2 (list 1000 200)
o3 (list 200 1000)
o4 (list 800 1000)
r 200)
u (GETANGLE "Valoarea unghiului u:")
(SETQ p1 (polar o1 u r)
p2 (inters o2 p1 o3 o4 nil)
l1 (polar p2 0 800)
l2 (polar p2 pi 800)
u1 (angle o2 p1))
(SETQ p3 (polar p1 (+ (*(/ pi 180) 30) u1) 40)
p4 (polar p1 (+ (*(/ pi 180) 150) u1) 40)
p5 (polar p1 (+ (*(/ pi 180) 210) u1) 40)
p6 (polar p1 (+ (*(/ pi 180) 330) u1) 40)
p7 (polar o2 (+ (*(/ pi 180) 30) u1) 40)
p8 (polar o2 (+ (*(/ pi 180) 150) u1) 40)
p9 (polar o2 (+ (*(/ pi 180) 210) u1) 40)
p10 (polar o2 (+ (*(/ pi 180) 330) u1) 40)
p11 (polar p2 (+ pi u1) 1000)

```

To conclude, these possibilities to perform the above presented animated representations are but a few of the more elaborated multiple techniques.

REFERENCES

1. Tarziu, H., *Examples of Using the CAD concept and CAE concept in the Study of Basic Technical Subjects*, Review of the Air Force Academy, Brasov, no. 2, 2007;
2. Manolea, D., *Programarea în AutoLISP sub AutoCAD*, Ed. Albastră, Cluj-Napoca, 1996;
3. *** Autodesk, Inc. *Fundamentals of AutoLISP*, 1994;
4. Târziu, H., *Medode grafice cu mijloace CAD*, Conf. Națională de Comunicări Șt. al a Academiei Forțelor Aeriene, Brașov, mai 2007.