PARAMETRIC DESIGN OF WORM GEAR ASSEMBLIES

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Abstract: The paper advances a 3D modeling of all components of a multipurpose anchor winch. The winch consists of a driving lever, braking lever, driving system, drum, frame and band brake. The paper gives a brief description of the parametric 3D modeling stages by making use of the Mechanical Desktop 6 software.

Keyword: CAD, Autodesk, 3D, Mechanical Desktop.

1. INTRODUCTION

The anchor winch is fitted on a suitable base plate on the ship open deck. The lever-driven input shaft transmits the rotation movement to the output shaft on which the drum is fitted to. It is impossible, however, to trasmit the movement rotation at the desired parameters because of the worm reduction gear. Movement is transmitted by means of a mobile wedge -coupling mechanism. Which is driven by a hand wheel. Anchor is kept raised by means of a ratchet mechanism fitted to the lever shaft until the brake is completely locked. In order to control the anchor lowering speed and keep the cable tensioned a manually driven brake is provided.

The anchor winch is set into operation by moving the lever fitted to the input shaft of the worm reduction gear. Acting upon the lever results in the anchor being raised provided the wedge-worm gear assembly is coupled. Coupling is quite easy to achieve by rotating a star-shaped tap. Complete coupling is achieved by rotating the tap counterclockwise 12 times. When uncoupling is desired the same is performed but clockwise. If, when coupling maneuvers are carried out, it is found that rotation 12 times is not possible, this means that the mobile wedge fails to follow the direction of the groove in the worm gear; in this case the lever should be operated manually by the "test and trial" procedure.

After having raised the anchor this is kept in position by means of the hand brake which is stuck to the drum. To lower the anchor the wedge is set free from the worm gear and the brake is released; this makes the anchor to lower gravitationally. During anchor rising, when releasing the lever, the anchor stays firm and does not lower due to the ratchet fitted to outside the reduction gear. In order to uncouple the drum more easily, provision was made to reverse the lever action by uncoupling the ratchet (in this case the anchor is kept in position by the brake).

2. THEORY OF THE WORM GEAR

The geometric elements of the worm gear are determined for the following input data: axial module $m_a = 4$, worm diameter coefficient $q = 11$, number of worm beginnings $z_1=4$, number of teeth of the worm gear $z_2=40$, gear transmission ratio $i_{12}=10$, teeth specific displacement $\xi_{f2} =0$, axial coefficient of the reference head $f=1$, axial coefficient of the bottom reference clearance $w=0,25$. Below are gave some of the computation formulas for the geometric elements characterizing the *Archimedes* worm gear:

- The reference diameter of the worm: $d_{01} = m_a \cdot q = 44$

- The division diameter of the wormwheel: $D_{d2} = m_a \cdot z_2 = 160$
- The external diameter of the worm: $d_{e1} = d_{01} + 2f \cdot m_a = 52$
- The external diameter of the wormwheeel: $D_{e2} = D_{d2} + 2\left(f + \xi_{f2}\right) \cdot m_a = 168$
- The back diameter of the worm: $d_{f1} = d_{01} - \left(f + w\right) \cdot m_a = 39$
- The back diameter of the wormwheel: $D_{f2} = D_{d2} - 2\left(f + w - \xi_{f2}\right) \cdot m_a = 150$
- The height of the worm reference head: $a_0 = f \cdot m_a = 4$;
- The height of the worm reference foot: $b_0 = \left(f + w\right) \cdot m_a = 5$;
- The height of the tooth worm and the gear: $h = a_0 + b_0 = 9$;
- The extent of the screw propeller worm: $p_a = \pi \cdot z_1 \cdot m_a = 50.265$;
- The diameter from the maximum top of the wormwhell: $D_{eM2} = D_{e2} + \dfrac{6m_a}{z_1 + 2} = 172$;
- The radius of the surface from the top wormwheel camber: $R'_{e2} = m_a\left(\dfrac{q}{2} - f\right) = 18$;
- The distance between the axis: $A_{12} = \dfrac{m_a\left(q + z_2\right)}{2} = 102$.

3. MODELING THE DRIVING SYSTEM

All modelings performed to obtain the final worm shape are based on entities type "Profile" geometrically restricted so that all defined modeling parameters no longer need further sizing and restrictions. During modeling profiles are to be plotted in previously defined plans. Figures 1, 2, 3 illustrated the worm shaft the driving system and the final assembly.

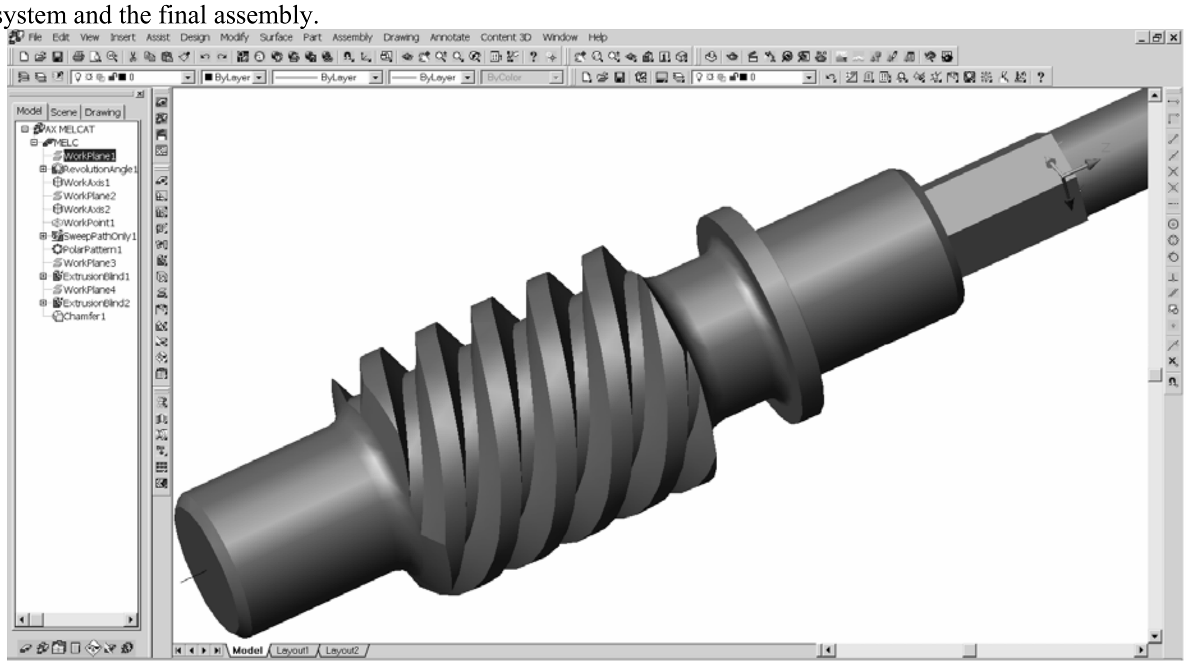

Fig. 1 Worm parametric modeling

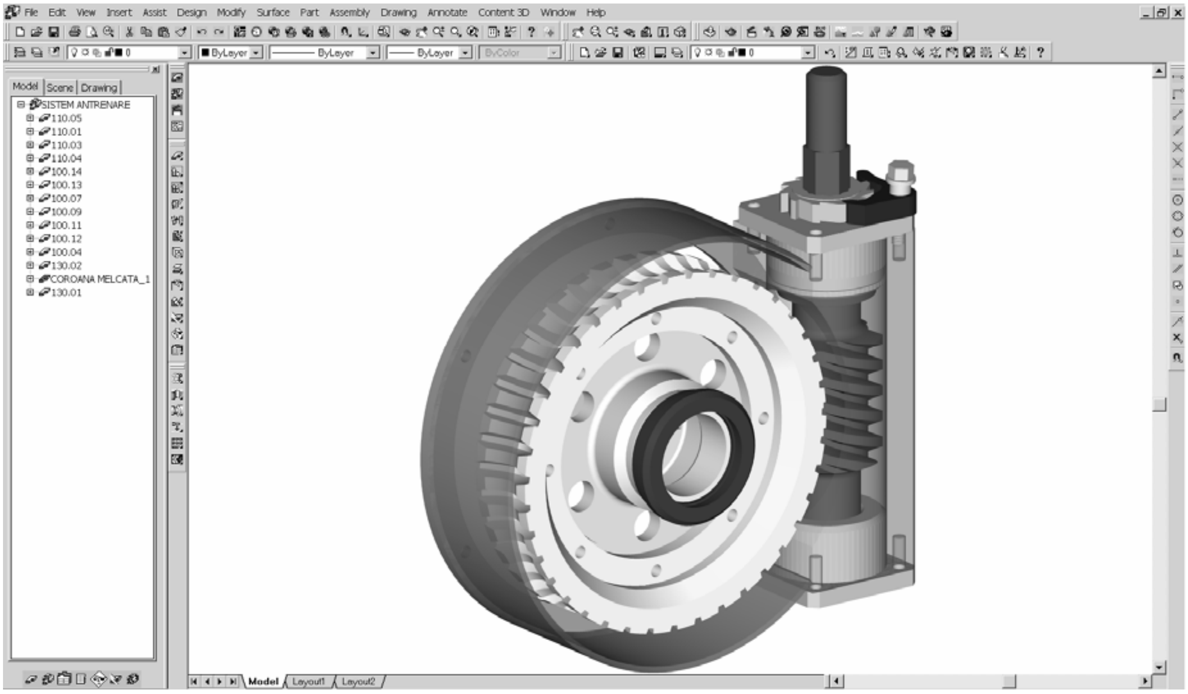

Fig. 2 Driving system parametric modeling

4. RESULT OF THE ASSEMBLY MODELING

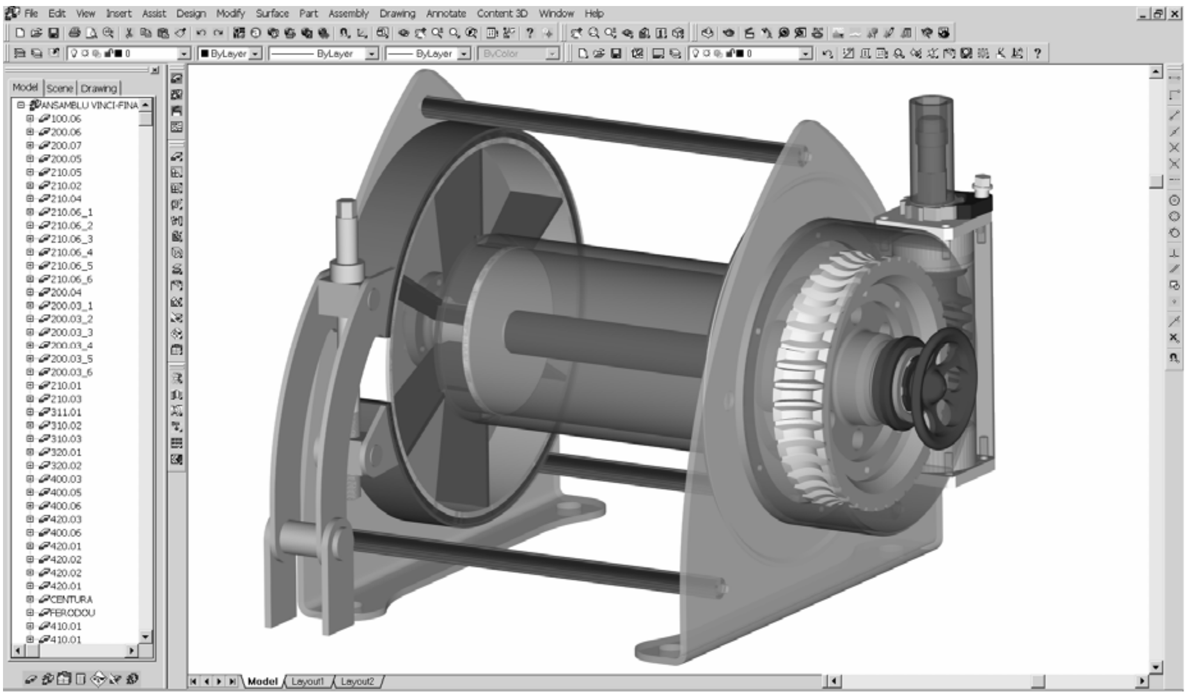

Fig. 3 Parametric model of an assembly containing the worm wheel

5. CONCLUSIONS

The advantages of a parametric design with Mechanical Desktop as compared with the classical one are:

- Use can be made of the option Component Manager to include existing pieces into other AutoCAD plotts (support Xref), to make assemblies with pieces from the current drawing and at any time it can be achieved the listing of the associated components and subassemblies;
- Making use of the parametric modeled solid pieces, the user can at any time evaluate the implications of the piece size modification.
- In order to design the assemblies, the user has a device for piece total or partial constraints.
- The facility Mechanical Desktop allows for analysis of collisions among the pieces making up an assembly, along with the related tables and views for the various assemblies etc.
- Automatic generation of the execution drawings and their bidirectional association with the 3D model represent the most important facility with this software.
- Drawings are generated in "Paper Space" and views having the following characteristics can be generated: base, orthographic, full sectional, offset sectional, iso-sectional, detail and user-defined.

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