

AIDED DESIGN OF THE DRIVE MECHANISM OF A CAR PLATFORM

Sorin Cristian ALBU

“Petru Maior” University of Tîrgu Mureș
Nicolae Iorga Street, no. 1, 540088 Tîrgu Mureș, Romania
sorin.albu@ing.upm.ro

Abstract

The purpose of this paper is to design the mechanism for lowering and lifting the car platform using CAD software (Inventor). The used mechanism to drive the car platform is the quadrilateral mechanism due to the low cost of its compared to a gear train. Operating a mechanism can be done manually by applying a force on frame attached on the crank or by operating through a small winch. Kinematic analysis was performed using the software mentioned above. Lowering the platform to ground level is necessary in some cases to be loaded heavy objects onto the platform when are not available forklifts and other lifting mechanisms.

Keywords: car platform, quadrilateral mechanism, axle, aided design

1. Introduction

According to manufacturer [10], [11], trailers and motor platforms can be divided into the following categories:

- Small trailers as in fig.1.a. [11] which can attach small cars, in this case are taken into consideration small car trailers that have closed four sides sometimes equipped with roof, trailers for boats and caravans used to transport boats or recreational vehicles;



Fig. 1: a. Small trailers, b. Small car platform

- Car platform fig.1.b. [11] designed to be towed by a larger vehicle, this category comprising auto platforms that have not closed four sides, used to car tow or Moto some of them being small enough to be towed using cars, tank trailers, container trailers, tractor trailers;

- Trailers for transport of special equipment which is towed by cars or special vans.
Small trailers can have one or two axes, their weight exceeding 1600 Kg.

In this article is studying the possibility of pursuing small trailers or small platforms equipped with a single axle, platforms whose weight does not exceed 750 Kg.

Often, for loading on small platforms the motorcycles, ATVs or some small weights but large enough to raise problems to a person is useful to lower the platform to ground level. This also applies to platforms and small trailers whose cost is not high and not fitted with special lifting mechanisms. These platforms are mainly used to transport motorcycles or ATVs.

2. The mechanism of articulated bars used

From economic considerations the solution chosen for operating mechanism is a quadrilateral mechanism, which is a linkage mechanism [3], [4], [5], [7], [13], [14] like in fig.2.

It will use the following terms:

- Kinematic element, this notion means a solid body consisting of a mechanical piece or several pieces rigidly assembled between them. Kinematic elements are considered rigid in most cases.
- Kinematic coupling is the connection between two mobile kinematic elements formed by direct contact between their surfaces.

The couplings used are kinematic coupling plane, allowing them to kinematic elements move parallel plan. An element is called crank if running full rotation and rocking called if the rotational movement is not complete.

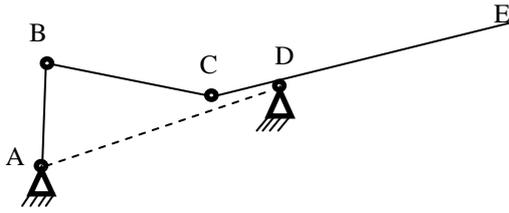


Fig. 2: Quadrilateral mechanism

Grashof's theorem [1], [2], [6] for articulated quadrilateral mechanism refers to the condition of existence of the crank: For an articulated quadrilateral mechanism to allow at least one crank is necessary and sufficient that the sum of the lengths of the smallest kinematic and the largest to be lower than the sum of the other two kinematic elements (1).

$$CD+AD < AB+BC \quad (1)$$

If this condition is met when kinematic CD is called crank. But in the present situation, rotational movement will not be complete so kinematic element CD will be rocking, so the condition (1) will not be respected.

3. The design of the mechanism used

The design of the mechanism is refer to the mechanism that meets the conditions imposed by the design theme (lengths elements, positions couplings). Initially is made structural synthesizes, which determines the structural scheme once the simplest for given problem.

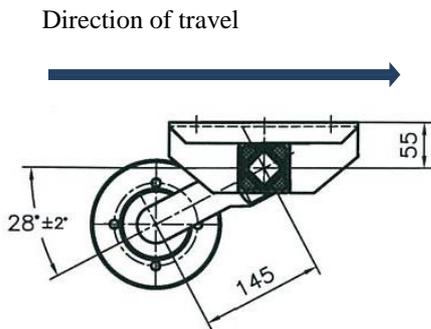


Fig. 3: Front view of the axle [12]

In the studied case is put the problem to descent a platform to ground level then to raise it in normal driving. The axle used to manufacture the platform is as in [12] fig.3, in frontal view, and in axial view fig.4.

It is noted that between the axle and wheel hub is an arm inclined at an angle of $28^\circ \pm 2^\circ$ to the horizontal being the normal operating position of the axle required by the manufacturer. On the axle will be installed two bushes around which the platform will be able to rotate. The wheels used are 165/70 R13, which means that the wheel diameter is 561 mm and the height of the wheel bead is 115.5 mm.

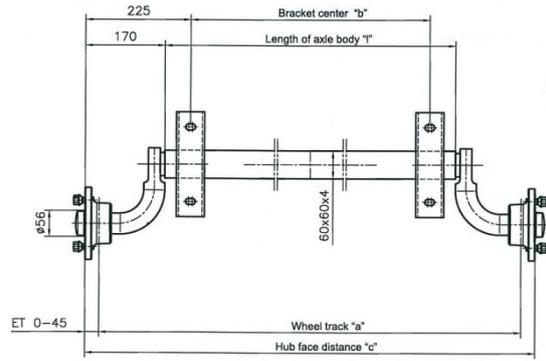


Fig. 4: Axial view of the axle [12]

For mechanism design is represented kinematic scheme of the platform seen from the side fig.5.

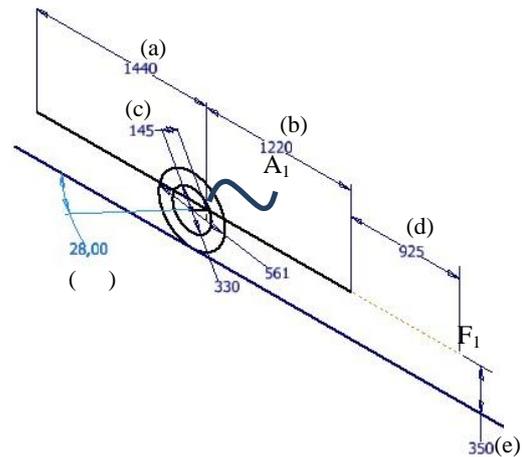


Fig. 5: Kinematic scheme of the platform

It can be seen that the platform length is p_1 mm, the distance from the axle at the rear of the platform is a mm and the distance from the axis to the front of the platform is b mm. The platform is rotatable around the axle that is positioned in the diagram in point A_1 located at the junction between the platform and the axle arm of c mm which is inclined at an angle of α_1 degrees to the horizontal. The platform is secured to the hook of the car from one point F_1 located at a distance of d mm from the platform at a height of e mm above the ground.

Table 1: Imposed value

Name parameter	Parameter	Value
Platform length	p_1 (a+b)	1660 mm
Distance between axle and the rear of the platform	a	1440 mm
Distance from the axis to the front of the platform	b	1220 mm
Axle arm	c	145 mm
Angle of the axle arm	α_1	28°
Distance from the platform of the hook	d	925 mm
Height of the hook	e	350 mm

For that the platform to be lowered to ground level will be able to rotate around a fixed point F_1 and around the axle (represented by point A_1) who will move up or down.

The conditions imposed in the present issue as shown in fig. 6. are:

- The axis arm for 145 mm length in operating conditions is inclined with 28 degrees to the horizontal in order to lower the platform at the maximum must rotate around the hub wheel with an angle of 118 . It is obvious that axle rotates with the same angle to the original position and will execute a translational movement.

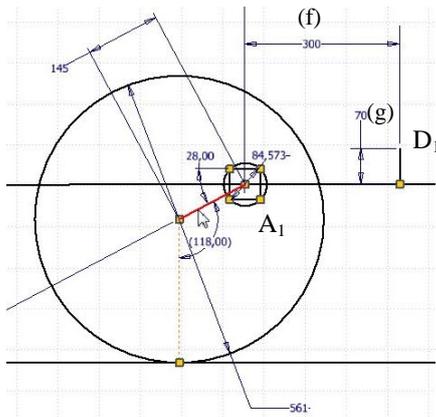


Fig. 6: Conditions to be respect.

- Point D_1 of fixing of the rocker is positioned at f (300) mm distance from the axle (point A_1) on the x axis and g (70) mm on Y axis.

- The rocker CD in the raised position of the platform will be parallel with the platform.

Is choose kinematic element denoted by AB upright and length of 115 mm. Point B will cover the distance where is expressed in radians fig.7.

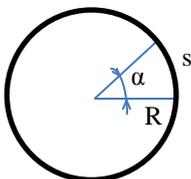


Fig. 7: Area traveled by a point

It required that in the raised position of the platform, the kinematic element CD with the length of 150 mm, must to be parallel with the platform. Is important to choose the greater length of kinematic element CD than the length of element AB because point C must to travel minimum the same distance as the point B at a maximum angle of 90° .

To determine the length of the kinematic element BC, analyze the motion of kinematic elements and operation of the mechanism is required to represent the kinematic scheme of mechanism in Inventor using constraints [8], [9] fig. 8.

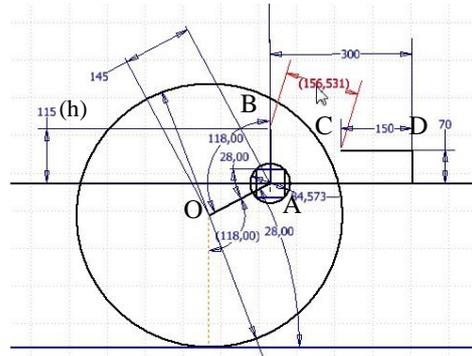


Fig. 8: Representing kinematic elements using constraints

Constraints used are: the wheel is tangent to the right represents the ground, point O of the arm between the hub and axle must coincide with the center of the wheel, kinematic element OA is rigidly by AB at an angle imposed, point A of the axle coincides with point A_1 belonging platform, point D of kinematic element CD coincides with point D_1 of platform.

Measure the distance between points B and C and represent a line of that length. Conditions that are imposed are the ends this line coincides with points B and C. For a better understanding of the mechanism will be represented circles in points where will be mechanism joints.

It is represented the mechanism in the first embodiment fig.9.

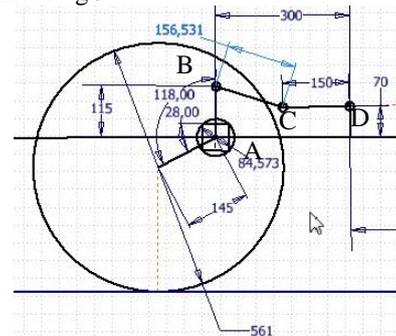


Fig. 9: Representation of the mechanism in the first embodiment

It analyzes the successive positions of the mechanism platform obtained by rotating the rocker CD. It is noted that in the position of the platform close to the ground, points A, B and C are collinear, mechanism in this position becoming unstable fig. 10.

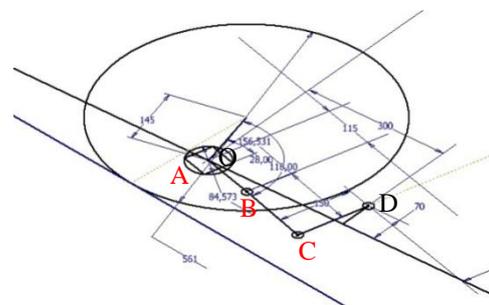


Fig. 10: The position of the unstable mechanism

To eliminate this situation it is noted that it is necessary rotation of the kinematic element AB to its previous position so as to be positioned in quadrant II trigonometric.

There will be iterations and will be analyzed the positions of the mechanism in each case, observing the following algorithm fig. 11.

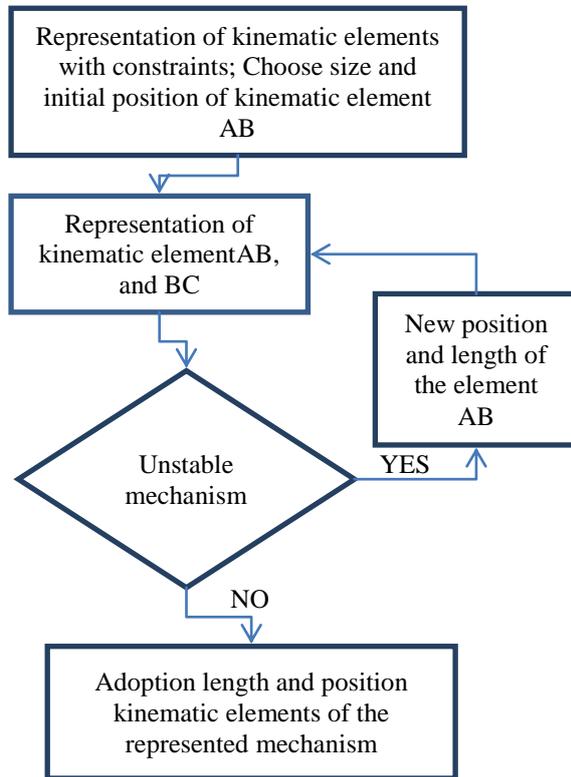


Fig. 11: Design algorithm

Following iterations was obtained functional mechanism fig. 12

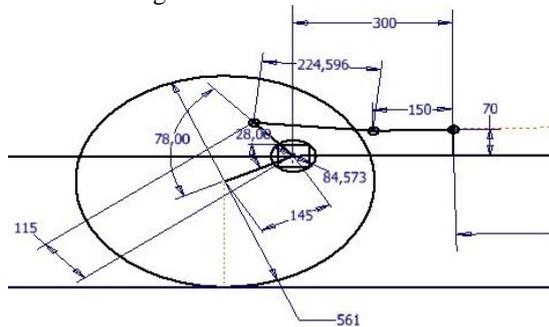


Fig. 12: The design mechanism

4. Conclusions

Using the method described above, and matching constraints can be designed complex mechanisms of linkage. Autodesk *Inventor* 3D CAD software is used with succes for product design and simulation of the mechanisms.

By using a quadrilateral mechanism was created the possibility of lowering a platform or a small trailer at ground level.

Thus, using *Inventor* software was designed mechanism necessary to handling an small car platforms making it easy to load it.

Acknowledgement

The authors thank Research Centre TAPFA of the Faculty of Engineering, “Petru Maior” University of Tîrgu Mures, Department of Industrial Engineering and Management and S.C. Delconf SRL for providing opportunities to use machines and equipments.

References

- [1] Alexandru Petre, Vișa I., s.a. (2001), *Designing Functional Mechanisms*, Ed. Lux Libris, Braşov, ISBN 973-9240-60-7.
- [2] Dudiță Fl. (1977), *Mechanisms*, Braşov University.
- [3] Neagoe M., Visa I., Cretescu N., Moldovan M. (2014), *On a New Parallel Tracking System for Accurate Orientation of Concentrated Solar Convertors*, Applied Mechanics and Materials, vol. 658, ISBN-13:978-3-03835-271-6, pp. 105-110.
- [4] Moldovan C., Sticlaru C. (2014), *On the Synthesis of a Five Bar Linkage for Linear Trajectory using a CAD Analysis*, Applied Mechanics and Materials, vol. 658, ISBN-13: 978-3-03835-271-6, pp. 105-110.
- [5] Neagoe M., Diaconescu D. (2009), *General method and algorithms used for accuracy modeling of parallel robots*, Int. J. of Biomechanics and Biomedical Robotics 1.
- [6] Gafițanu, M., ș.a., *Machine parts*, vol. 2. Editura Tehnică, Bucharest.
- [7] Pozdîrcă A. (2010), *Calculation and representation of curves and surfaces*, „Petru Maior” University Press, ISBN 978-973-7794-91-8.
- [8] Pozdîrcă A., Albert K. (2004), Chețan Paul, *Inventor – Parametric modeling*, CAD&CAM collection, Modul 04.
- [9] Albu, S. (2015), *The Coordinate Transformations Method Combined with AutoLisp to the Archimedean Spiral Representation in Autocad*, Scientific Bulletin of the “Petru Maior” University of Tîrgu Mureș, ISSN 2285-438, vol. 12, no. 2, pp. 22-25.
- [10] <http://www.remorci-padis.ro>
- [11] <http://www.repo.com.ro/ro/remorci>
- [12] <http://www.knott.ro/osii-fara-frana/16-o-sii-fara-frana-pana-la-750kg.html>
- [13] Dudiță F., Diaconescu D., Gogu Gr. (1989), *Articulated mechanisms*, Technical Publisher, Bucharest.
- [14] Pelecudi Chr., Maros D., Merticaru V., Pandrea N., Simionescu I. (1985), *Mechanisms*, Ed. Didactical and Pedagogical, Bucharest.