T4H COLLECTIBLE PHYSICAL OBJECT CERTIFICATE

Phibocycle 618 Aboca

Scale model of a golden ratio based 4-wheel vehicle

Phibocycle 618 Aboca – Amber & Green edition (translucent)

Material: PLA and TPU. Embedded NFC TAG UID 02:E3:01:22:5B:B4:FF

The minor 3D printing imperfections in this product are an integral part of its unique artisanal nature, which reflects the digital crafting process. We invite you to appreciate these imperfections as distinctive features rather than defects.

This physical object is an experimental bioplastic 3D printed collectible toy prototype: keep far from heat sources above 45°C and children aged under 14 years

Phibocycle 618 is a 3D printable imaginary essential quadricycle: curves and basic 2D construction lines have been set in dimensional ratios of the golden ratio; and connected to each other, binding them to be mutually tangent.

The whole number 80.00 (expressed in mm) has been chosen as the base number[1] from which to derive multiples and submultiples calculated according to the constant Phi (also defined as Golden Number or Golden Ratio[2]) usually indicated by the Greek lowercase letter[3] φ, and whose value is equal to 1.6180339887[4].

The diameters and radii of the circles (or arcs of circumference) used to make the 2D drawings are listed in Table 1 below.

***Phibocycle 618* - Table 1. Numerical sequence and ratios of measurements used for the graphical construction of *Phibocycle 618*.**

Sequence of the integer 80 second multiples or submultiples of Phi	Measurements of the diameters or radii used in the 2D construction of the drawing (in mm)	Measurements with number rounded to the third decimal place (in mm)	Nearest Fibonacci Number (in cm)
80,00 x 1,6180339887 =	**129,442719096**	129,443	13
BASE NUMBER	**80,00**	**-**	**8**
80,00: 1,6180339887 =	**49,442719101516239**	49,443	5
49,442719101516239: 1,6180339887 =	**30,557280901892984**	30,557	3
30,557280901892984: 1,6180339887 =	**18,88543820173027**	18,885	2
18,88543820173027: 1,6180339887 =	**11,671842701464921**	11,672	1
11,671842701464921: 1,6180339887 =	**7,213595501070157**	7,213	-
7,213595501070157: 1,6180339887 =	**4,458247200892163**	4,458	-
4,458247200892163: 1,6180339887 =	**2,755348300485403**	2,755	-

[1] 8 is a number of the Fibonacci sequence

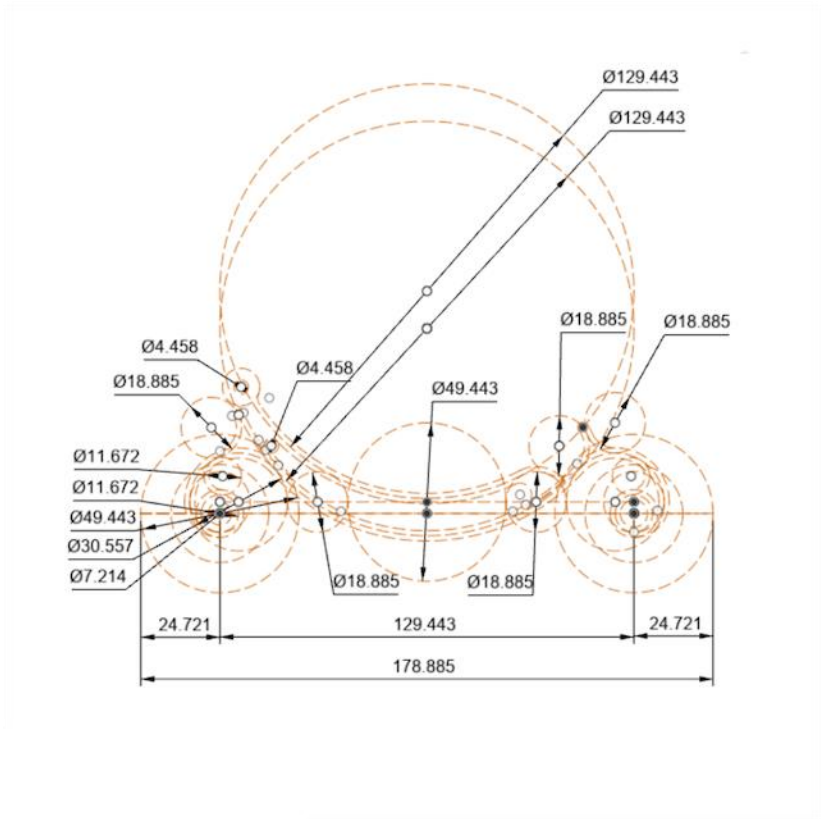
[2] https://en.wikipedia.org/wiki/Golden_ratio. See also Relationship to Fibonacci sequence https://en.wikipedia.org/wiki/Golden_ratio#Relationship_to_Fibonacci_sequence

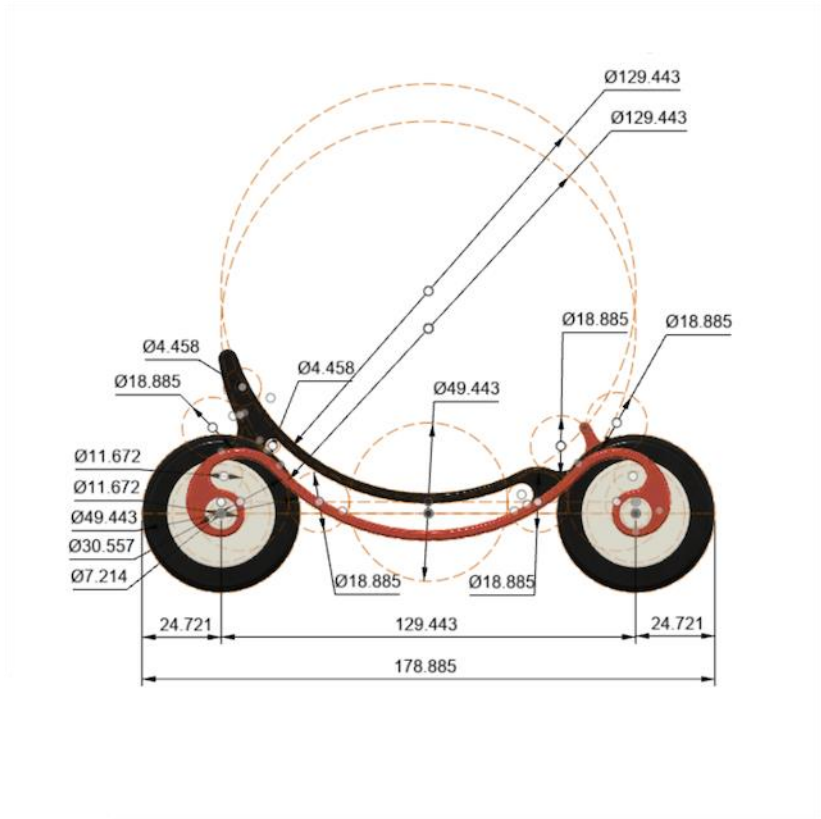
[3] The Greek letter Phi symbolizes the golden ratio; usually, the lowercase form φ. Sometimes the uppercase form is used for the reciprocal of the golden ratio.

[4] Phi is an irrational number, for the calculations of multiples and submultiples of 80 in the table we have chosen to approximate Phi to the tenth decimal place.

The resulting drawing is to be considered in 1/16 scale.[5] The graphic declination of the numerical sequence described and listed above is explained in Tables 2 and 3.

***Phibocycle 618* - Table 2. Side view (2D construction and 3D extrusion)**



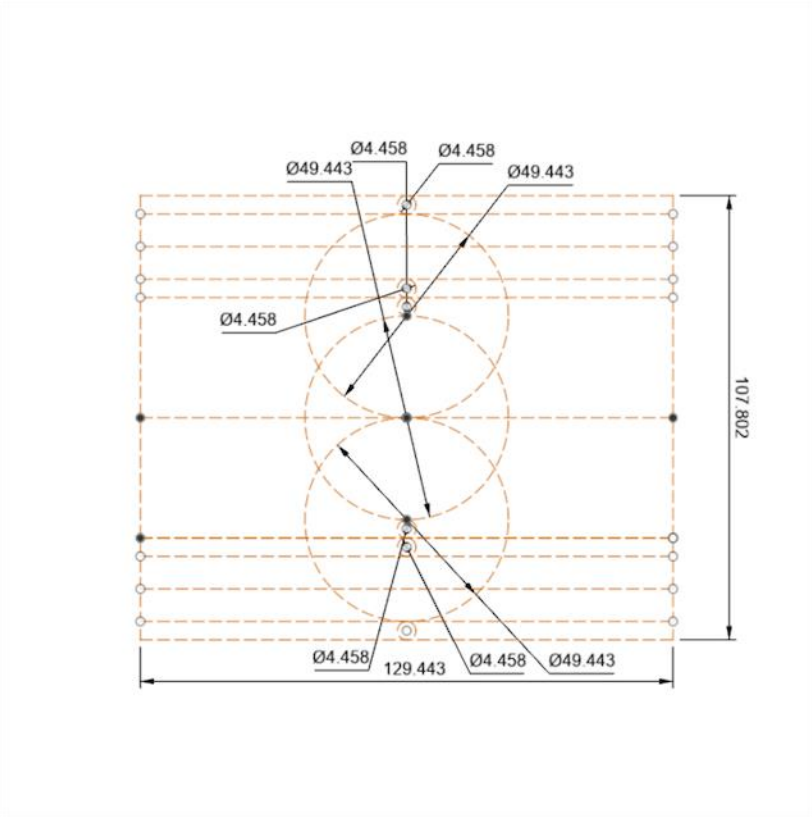


[5] Exactly 1 / 16.18

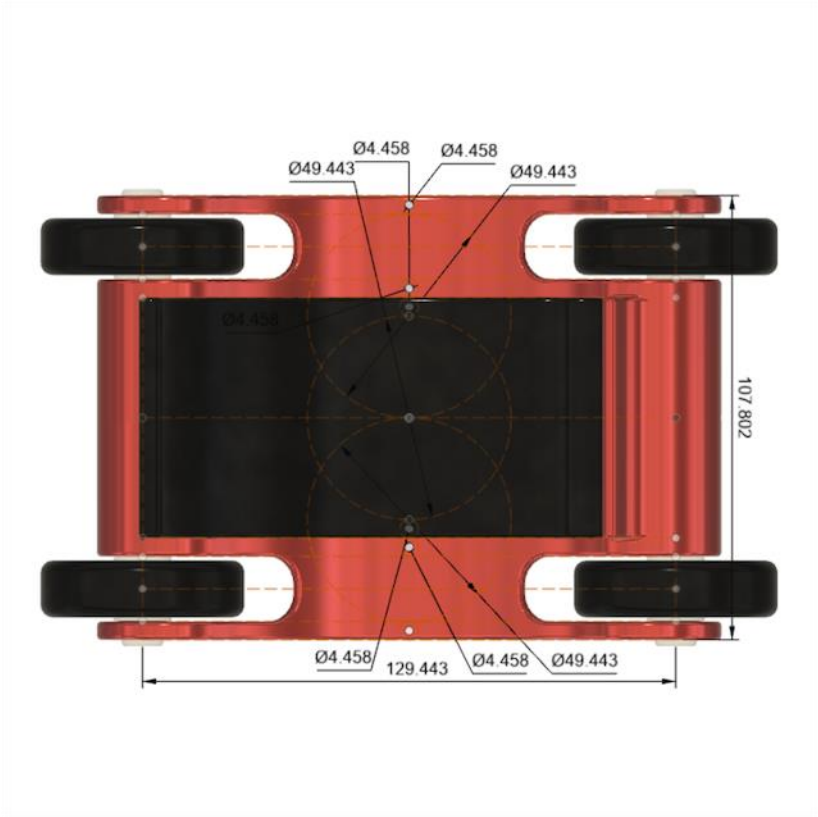
Phibocycle 618 - Figure 1. 2D construction side view	*Phibocycle 618* - Figure 2. 2D construction and 3D body side view

Phibocycle 618 - Figure 3 - 3D body. Side view

Phibocycle 618 **- Table 3 – 2D construction and 3D extrusion**



Phibocycle 618 - Figure 4. Construction seen from above



Phibocycle 618 - Figure 5. 3D body seen from above

For the walls of *Phibocycle 618*, the value of 3.2 mm was chosen, creating for this purpose symmetrical external and internal offsets of 1.60 mm per side of the construction lines dashed in orange in Table 5. The choice of the value of 3.2 mm derives from various considerations:

1. Resistance of the object in relation to the size (especially the wheel supports).

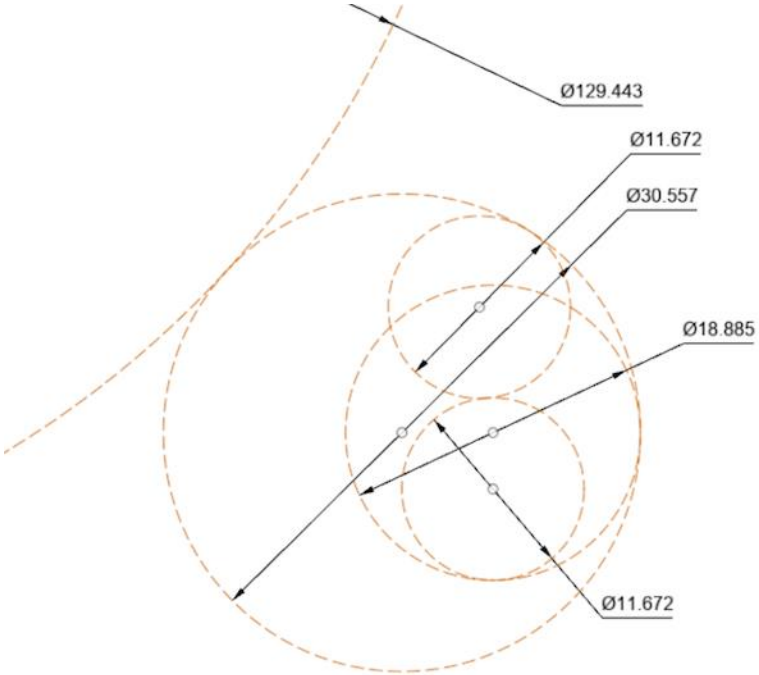
2. In case of resizing the object according to the golden value of Phi and thus obtaining an object at a scale of approximately 1/25[6], the value of the wall would become approximately 2 mm while maintaining the necessary mechanical strength.

3. In case of downsizing by 50% (thus passing to the 1/32 scale) the wall reduced to 1.6 mm would maintain sufficient resistance even in the most stressed points.

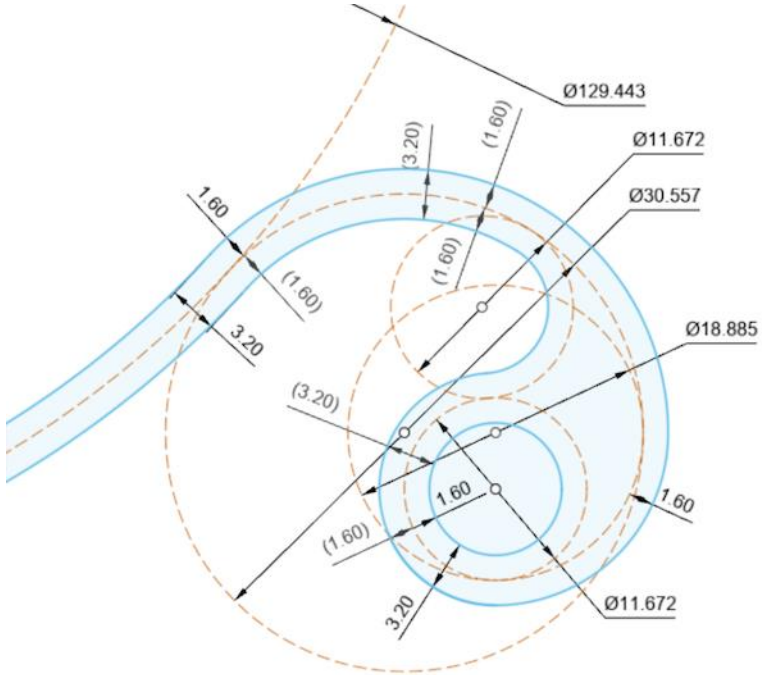
Wall thicknesses greater than 3.2 mm were excluded, both for stylistic reasons as they would have made the drawing heavier, and for considerations relating to the printing time and the amount of material needed.

[6] For accuracy 1/16 x 1.618 = 1 / 25.888

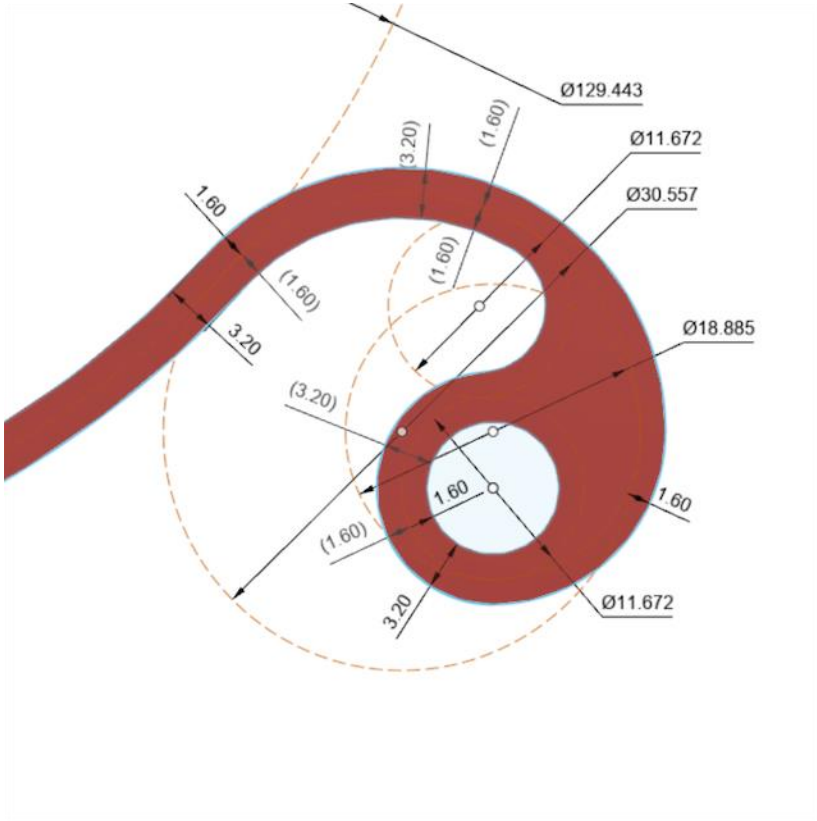
***Phibocycle 618* - Table 4. Example of construction and connections with (detail of the external wheel support)**



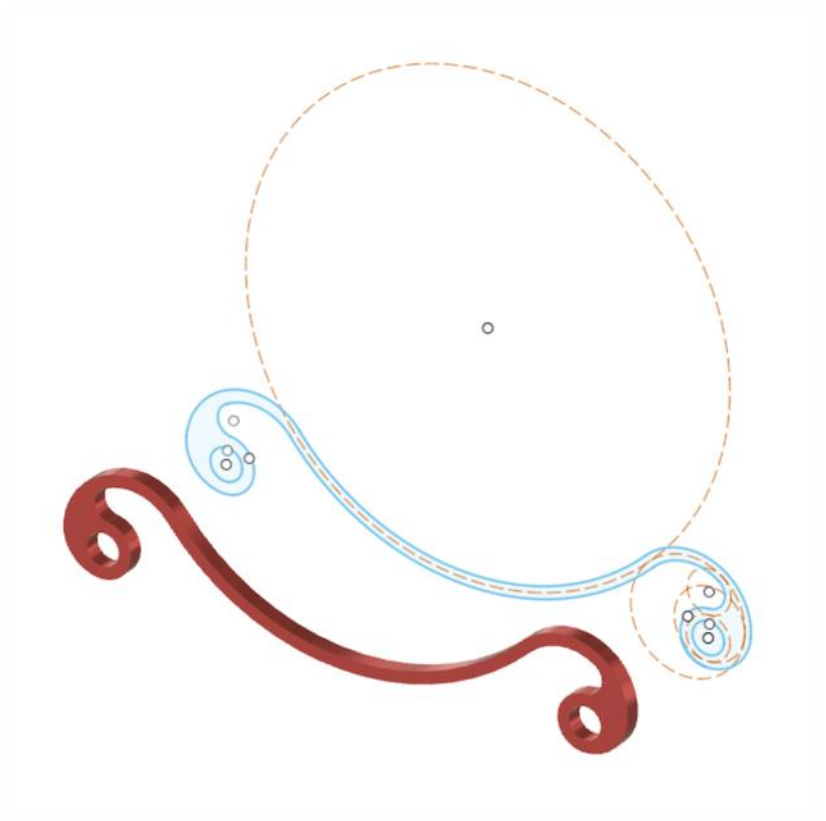
Phibocycle 618 - Figure 6. Construction curves of the wheel carrier dashed in orange. The curves are connected to each other as tangent curves.



Phibocycle 618 - Figure 7. The construction curves of the wheel support dashed in orange and the curves resulting from the 1.60 mm offset in blue.

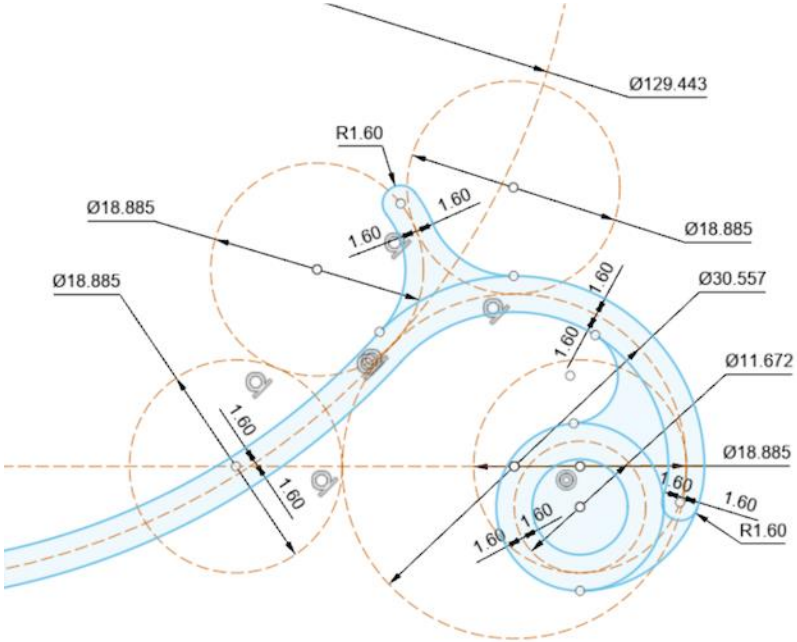


Phibocycle 618 - Figure 8. The detail of the wheel support in 3D. The blue curves generated by the offset delimit the 3.2 mm thickness of the wall

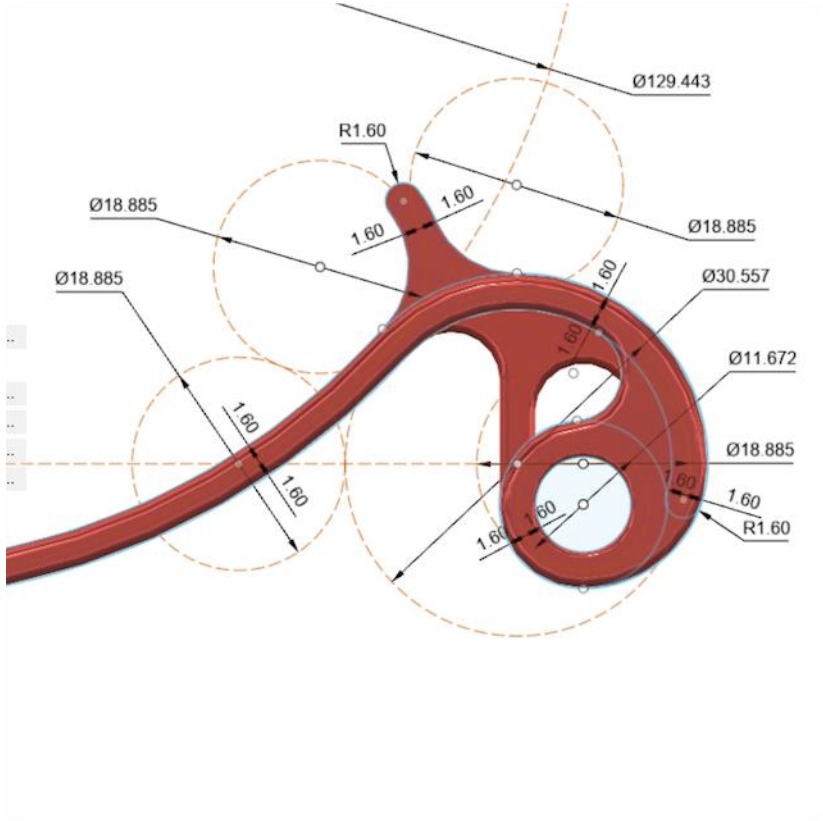


Phibocycle 618 - Figure 9. Overview of the construction of the front and rear wheel supports and their connection.

***Phibocycle 618* - Table 5. Highlighted example of the connections with tangent rims (detail of the internal and external wheel support and of the "front windshield")**



Phibocycle 618 - Figure 10. Construction curves dashed in orange and the curves resulting from the offset of 1.60 mm in blue. The curves are connected to each other as tangent curves.



Phibocycle 618 - Figure 11. The detail of the wheel support and the "windshield" in 3D. The blue curves generated by the offset delimit the 3.2 mm thickness of the wall.

Here are the other images of the *Phibocycle 618* drawing made in Autodesk.

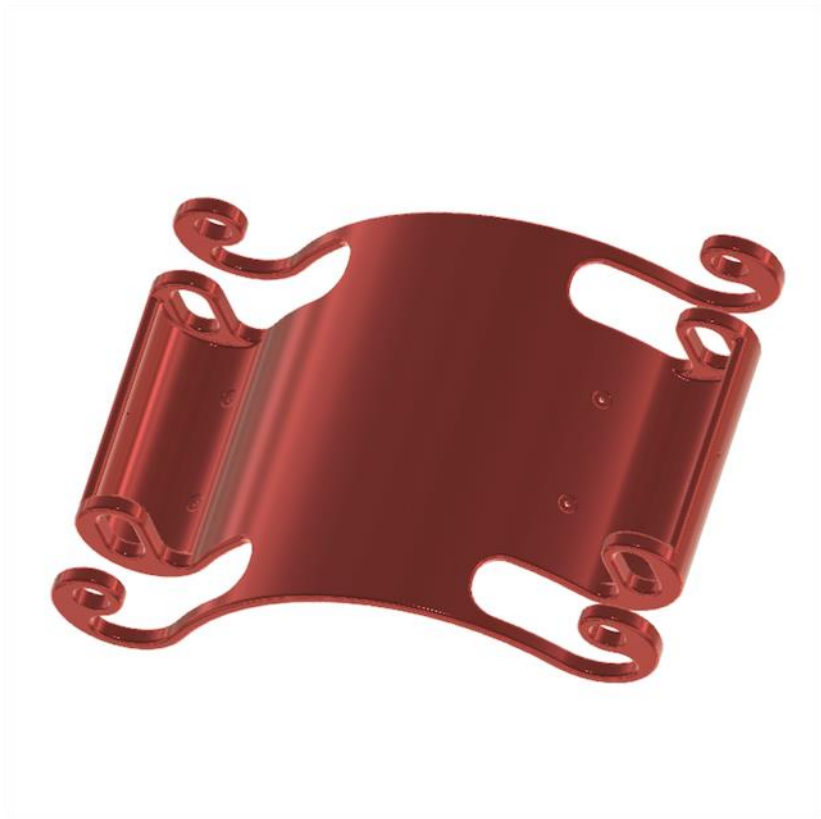
***Phibocycle 618* - Table 6. *Phibocycle 618* - Front three-quarter view**

Phibocycle 618 - Figure 12. Standard version front three-quarter view.

Phibocycle 618 - Figure 13. Standard version rear three-quarter view.

Phibocycle 618 - Table 7. Rear three quarters

Phibocycle 618 - Table 8. Bottom frame view

	
Phibocycle 618 - Figure 14. View of the lower frame standard version.	*Phibocycle 618* - Figure 15. Bottom view of the frame without wheels standard version and of the 4 pre-setting holes for screws (1.2 mm diameter for 1.4 mm diameter screws).

Phibocycle 618 - Table 9. Top view of the frame with backrest housings (or other possible modules such as carriage, closed cockpit, etc.)

Phibocycle 618 - Figure 16. Top view of front three-quarter wheelless frame with rear seat for backrest.

Phibocycle 618 - Figure 17. Rear three-quarter frame top view with front seat for backrest.

Phibocycle 618 - Table 10. View of the backrest isolated from the frame

Phibocycle 618 - Figure 18. Top view of the backrest with frame slots.	*Phibocycle 618* - Figure 19. Bottom view of the backrest with 4 holes (1.2 mm diameter for 1.4 mm diameter screws).

Phibocycle 618 - Table 11. Hub and housing of elastic and semi-constrained wheel supports (external top view)

Phibocycle 618 - Figure 20. The wheel hub inserted in the external housing (constrained and elastic) and the internal one (the internal part of the hub attachment is semi-constrained to obtain limited oscillation).[7]	*Phibocycle 618* - Figure 21. The hub with the two rigid spacer washers and the distal rubber washer inserted into the locking groove of the hub. For the detail of the hub locking system, see the following table.
	

[7] The sizing of the semi-constrained internal part of the hub attachment to obtain limited oscillation and prevent stress on the front support required several printing tests of the frame with varying degrees of constraint. The dimensioning achieved allows the wheels to oscillate independently and the ability of *Phibocycle 618* to withstand the crushing by the child at the end of the stroke without breaking or evident stress of the external elastic supports. Phibocycle crush tests were done which held the weight of a four-year-old.

Phibocycle 618 - Figure 22. Detail of the frame support for the wheels (elastic outside and constrained hole, rigid inside and semi-constrained hole).	*Phibocycle 618* - Figure 23. Hub with detail of the distal groove for press fit with rubber stop washers (TPU).[8]

Phibocycle 618 - Table 12. Phibocycle 618 - Tire, hub and housing (bottom internal view)

[8] The sizing of the hubs required numerous printing tests to adapt the tolerances and have diameters and distal groove, which were compatible with the insertion of rigid washers, rims, frame and rubber lock washer.

Phibocycle 618 - Figure 24. The wheel and hub inserted with the distal rubber locking washer inserted into the hub groove.

Phibocycle 618 - Figure 25. View of the wheel support without wheel and hub; and detail of one of the 4 holes on the predisposition frame for screws; b) the rear hole of the 2 predisposition holes (one front and one rear) for the tow rope or for screws useful for fixing any other accessories (tow hook, logo, plate, etc.)

Phibocycle 618 - Table 13. Rim and tire

Phibocycle 618 - Figure 26. Rim with detail of the external circumferential median track for pressure fitting with tire.

Phibocycle 618 - Figure 27. Tire with detail of internal circumferential median groove for press fit with rim.

***Phibocycle 618 NFC*: creation of housing for NFC TAG insertion and use of Blockchain/NFT technology**

To make each print made traceable and enter specific information on each individual object produced, we have created an internal pocket of 31x31 mm in the thickness of the *Phibocycle 618* frame capable of housing an NFC TAG with a maximum size of 30.5x30.5 mm[9] (see Table 14). The TAG can be sealed inside the pocket in such a way that it cannot be removed without breaking the *Phibocycle 618* frame. The NFC TAGs are equipped with a unique alphanumeric code (UID id) and can be written permanently and unalterably by inserting links to videos, dedicated web pages or certificates in blockchain / NFT containing the unalterable data of the buyer, the donor, the name of the recipient, and other personalized text messages; and able to possibly record the changes in ownership of the object and / or of the connected NFT certificates. Such information can be public or made private protected by a password. The NFC TAGs are readable by a transponder which today the vast majority of smartphones already in circulation are equipped with.

***Phibocycle 618 NFC* - Table 13. NFC TAG pocket**

[9] NFC TAG used: rounded ST-25TA02-29. ST25TA series chip. Supports: password protection both for read and write; up to 1 million read/write cycles and 200 years of data retention. ST25TA02KB NFC Chip Technical Specifications ISO/IEC 14443 Type A NFC Forum Type 4 Tag Operating frequency: 13.56 MHz 7-byte unique identifier (UID) Available memory: 2 kbit / 256 byte 128-bit password protection both for read and write memory 20-bit scan counter 200 years data retention 1 million write erase cycles TruST25™ digital signature Sticker Specifics Diameter: 29 mm (white sticker) Overall thickness: 120 µm ± 15µm Operating temperature: from -25°C to 70°C / from -13°F to 158°F Material: PP, Aluminium. https://www.shopnfc.com/en/nfc-stickers/311-586-nfc-stickers-st25ta02k-round-29mm.html#/29-custom_printing-no

Phibocycle 618 NFC – Figure 28. *Section showing the pocket for NFC (31x31 mm)* created in the thickness of the walls of Phibocycle 618