# UNFOLDINGS METHODS OF THE CYLINDRICAL SURFACES


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***Abstract.*** *This paper aims to solve some reductions that are part of the ventilation and conditioning installations, whose routes are subject to limited space and possibilities of installation. The drawing unfoldings and cutting sheets to obtain the bending operations and combining of parts or subassemblies of complex form, is a common application met in industry.The graphical solving of the problems of technical representation has enabled the formation of abstract geometric of the pieces forms and the ability to see into space. The paper proposes to establish the unfolding of a connection, used in the industrial equipments, by the classical method of the descriptive geometry and mathematics, using appropriate software.*



***Keywords:*** *cylinder, intersection curve, unfolding, methods.*


## 1. INTRODUCTION

This paper addresses a theme met in technical design of the connections in which the knowledge of the unfolding of the geometric elements, which compose them, is the basis of making, required in installation.

The design, the execution and their installation requires tracing of the unfolding of the geometric elements of the respective connection [1,2]. The intersection of three cylinders of equal diameter $D = 30mm$ and axis concurrent, inclined with an angle of $60^{0}$ is considered (Figure 1). This connector connects to the main pipe that has a flat oval shape [6].

This paper aims to resolve in two ways, by methods of the descriptive geometry and mathematics, such an application.

## 2. DESCRIPTIVE GEOMETRY METHOD

The problem can be reduced to an intersection of cylinders with equal diameters and axis concurrent inclined at a known angle. Because of the symmetry of the case only unfoldings of the middle is determined. To determine the curve of intersection between the cylinders, we use the method of the auxiliary planes (Figure 1).

The number of auxiliary planes is bigger, obvious the accuracy of the intersection curve is higher. To determine the intersection points that define the curve, the middle and horizontal (lateral) cylinder bases are divided into 8 equal parts, having the points $m, n, ..., v$, respectively the points $1, 2, ..., 8$. Through these points, the limit planes $f_1, f_2, ..., f_5, l_1, ... l_5$ are constructed. At the intersection of the corresponding planes the $m5, n4 = v6, p3 = u7$, intersection points of the curve are obtained. It is obvious that the true sizes of the generators are measured in the vertical plane.

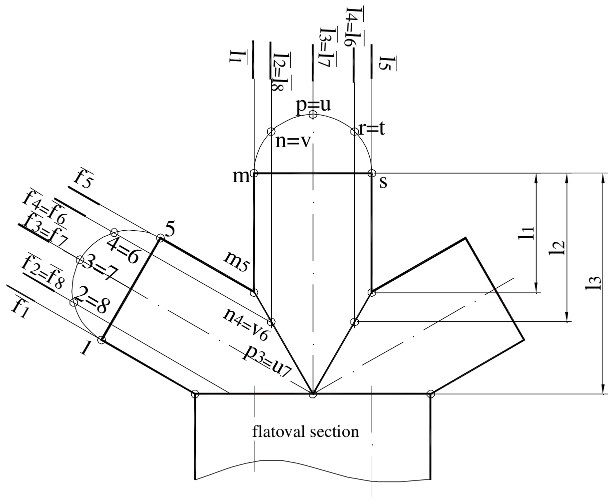


**Figure 1. Connections intersection**

The unfolding will be a rectangle, with a side length equal to the base circle and the other side equal with the $l_1, l_2, ..., l_5$ lengths generators.

The Figure 2 shows the unfolding of the middle cylinder, where the length of the segment is $\overline{M_0 M_0} = 2\pi 30$, and the other dimension is $\overline{M_0 M_{50}} = l_1, ..., \overline{P_0 P_{30}} = l_3$.

The points of the intersection curve will be: $M_{50}, N_{40}, P_{30}, ... M_{50}$.

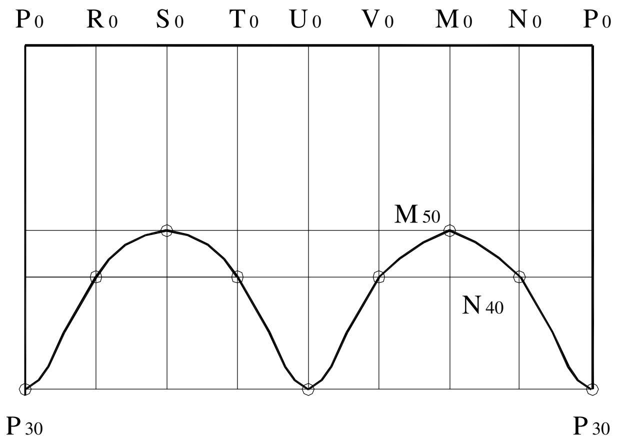


**Figure 2.Unfolding of the middle cylinder**

## 3. MATHEMATICAL METHOD

In the Figure 3 is presented the setting way of the cylinders. For the $C_2$ cylinder, the equation of the transformation curve, is obtain by applying the transformation (2), (3) to the equation (1), [3-6].

$$z = x\, tg\beta,\ x \in [-R, R] \quad (1)$$

$$x = R \sin\alpha \quad (2)$$

$$z = z_d,\ \alpha \in [0, 2\pi] \quad (3)$$

in this case: $x_d = R\alpha$

$$x = R \sin(\frac{x_d}{R})$$

$$z = z_d$$

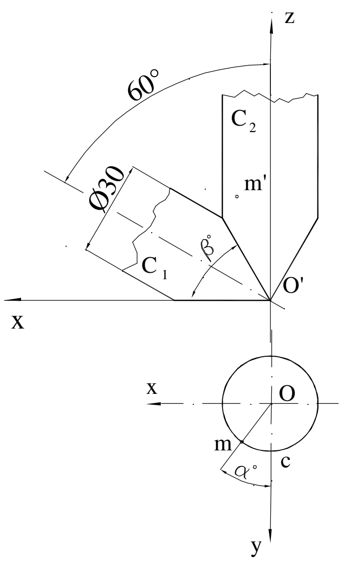


**Figure 3.The geometrical elements of cylinders**

Those we obtain:

$$z_d = tg\,\beta\,(R\,sin\frac{x_d}{R}) \qquad x_d \in [0, 2\pi R] \quad (4)$$

For an angle $\beta = 60^0$ and a cylinder radius $R = 15mm$, we obtain the Figure 4, by introducing the relation (4) into the Mathematica program.

The Figure 4 show the unfolding for the $C_2$ cylinder.

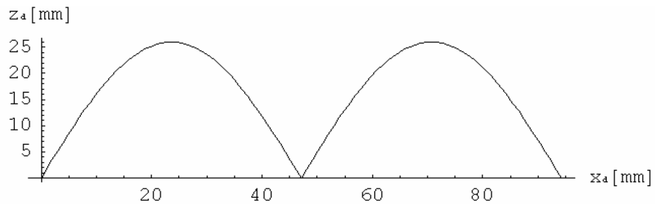


**Figure 4. Unfolding of the middle cylinder**

For the others cylinders their unfoldings are identical.

## 4. CONCLUSIONS

For the correct execution of some pieces or subassemblies with complex form, which meet the requirements, the methods of descriptive geometry are absolutely necessary. Resolve the difficulties of producing patterns, by determining the types of surfaces that are part of that is very necessary.

The presented method is very speedy and exactly and using the program we can obtain the cylinders unfoldings for any other dimensions. The two methods have the same results.

## REFERENCES

[1] Moncea, J., Desfasurarea suprafetelor, Editura Tehnica, Bucuresti, 1989

[2] Popescu, Tr., V., Geometrie descriptivă, Editura Universitaria, Craiova, 2004

[3] Popa, Carmen, Petre, Ivona, Costache, I., Analytical methods to determine the intersection curves of the cylinders, Romanian Journal of Technical Sciences, Tome 49, 2004, pag. 595

[4] Jänlich K., Analysis für Physiker und Ingenieure, Springer Verlag, Berlin, 2001

[5] Marin, Gh., Cîrstoiu, Adriana, Manescu C., Negrea A., Descriptive geometry, graphical solution base of some engineering applications, Acta Technica Napocensis, Series: Applied Mathematics and Mechanics, 52, Vol. Ia, Technical University of Cluj-Napoca, ISSN 1221-5872, pag. 165-168, 2005

[6] Popa, Carmen, Petre, Ivona, Vasile, Gheorghita, Unfoldings of the cylindrical surfaces used in the industrial installations, Revista Fiability and Durability, Universitatea Constantin Brancusi din Tg. Jiu, nr. 2, ISSN 2344-3669, ISSN-L 1844-640X, pag. 3-8, 2013.