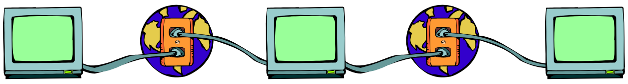

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Şos. Olteniţei nr. 103, sector 4, O.P. 8
Tel: **021 332.37.70/234**
Fax: **021 332.07.75 / 021 332.31.95**
E-mail: ictcm@ictcm.ro

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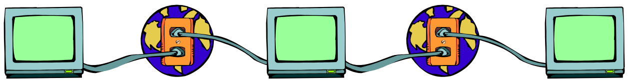

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AUTOMATIC CUTTING TOOLS SELECTION FOR HELICOPTER BLADES MOULD MANUFACTURING

R. Udroiu
Transilvania University of Brasov, Brasov, ROMANIA, e-mail:udroiu.r@unitbv.ro

The paper presents an application which objective is to provide a software tool for the integrated engineering of the complex parts. Thus, the article is focused on the automatic determination of virtual cutting tools in three-axis milling process of sculptured pockets. The main objective of this article is development an software tool called VTOOL (Virtual cutting Tools) whith applications in helicopter blade manufacturing. The software program is achieved with the help of tools of development Visual Basic and CAD/CAM system PoweShape / PowerMill from Delcam.

CNC MILLING OF SPIRAL SHAPE CONTOURS USING FACS-15 SOFTWARE SYSTEM

Camil Lancea
Transilvania University of Brasov, Brasov, ROMANIA, camil@unitbv.ro

Any kind of chip removing process, but not only, of the parts, surfaces or contours must be done today by using modern techniques that implies the use of computer-aided systems. In other words, any modern machining process involves the use of CAD / CAPP / CAM / CAE equipment. In accordance with the new concepts of engineering, as modelling engineering and simulation engineering, all related information with the geometric modelling phase (CAD) must be saved in order to access them both within the process planning phase (CAPP) and in the manufacturing phase (CAM). This paper presents a software package whose interface provides a number of facilities, both in the contours design phase and in its manufacturing phase, resulting by the automation of both processes. This is possible by using original default CAD geometries. These geometric configurations, in so far as we know, cannot be generated automatically by any other CAD / CAPP / CAM / CAE software from the market.

The software package also allows, within the CAD phase, to modify quickly the shape of the elements that defines the contours. Other advantages of this system refers to the Romanian language commands and also the favourable purchase price, compared to other similar CAD / CAM / CAE CNC milling systems, such as: CATIA, Pro Engineer, Solid Works, Power Mill etc.

ANALYSIS OF THE AERODYNAMIC PERFORMANCE OF A POWERED SAILPLANE FROM CS 22 CATEGORIES

S.M. Zaharia
Transilvania University of Brasov, Brasov, Romania, zaharia_sebastian@unitbv.ro

The aircraft is a complex mechanical system with a large number of degrees of freedom, with complex applications with different aerodynamic forces and moments. By developing techniques for flight simulation and airflows, they allow determination of the aerodynamic characteristics of an aircraft in a short time. In this paper it was determined aerodynamic performance (lift, drag, coefficient of pressure) of a powered sailplane category CS-22 rules for different flight regimes. The variation curve of drag coefficient depending on the angle of incidence was determined for the wing profile, for complete wing and full powered sailplane. Preliminary analysis of a powered sailplane aerodynamics analysis using specific programs is achieved in a short time, with minimal material costs quickly determining the main characteristics of flight.

RESEARCHES CONCERNING THE ACHIEVEMENT OF AN INTEGRATED DOSING SYSTEM FOR THE BINAR LUBRICANT FLUID

I. Radulescu, A. V. Radulescu
POLITEHNICA University from Bucharest, ROMANIA, e-mail: irena_sandu@yahoo.com

The paper presents a study for the achievement of an integrated dosing system for a binary lubricant fluid, followed by an evaluation of its tribological properties and a comparison between this one and the classical pump-driven liquid lubrication solution. An experimental stand was design and realized, in order to test a standard gearbox, alternatively lubricated with both systems. The influence of the two lubrication systems on the performance of the gears and ball bearings was investigated, with variations of load and speed. Statistical techniques were used to design an efficient experimental plan. The dependent variables chosen to be monitored in this experiment were the operating temperature and the level of noise. The extended tests show that the binary lubrication system offers better performance than the classical lubrication system.

SISTEME ELECTRONICE DE ACHIZIŢII / DATA ACQUISITION SYSTEMS

Mihai Preda, Alexandru Valentin Rădulescu

POLITEHNICA University of Bucharest, Bucharest, ROMANIA, e-mail: varrav2000@yahoo.com

This article approaches the opportunity of transitioning an organisation to an e-procurement model, by showing both theoretically, as well as practically, using a case study, the superiority of such system from a cost and efficency point of view, to a traditional procurement process. The purpose of the case study is to showcase the simplicity and accessibility perceived by the end user through the user interface, while not making any compromises with regard to the complexity and thoroughness of the back-end process.

AUTOMATIC CUTTING TOOLS SELECTION FOR HELICOPTER BLADES MOULD MANUFACTURING

R. Udroiu

Transilvania University of Brasov, Brasov, ROMANIA, e-mail:udroiu.r@unitbv.ro

REZUMAT
Articolul prezintă o aplicatie al carui obiectiv este realizarea unui instrument software pentru ingineria integrata a produselor complexe. Astfel, articolul este axat pe determinarea automată a sculelor aschietoare virtuale în procesul de frezare in trei axe a buzunarelor sculpturale. Obiectivul principal al acestui articol este dezvoltarea unui instrument software denumit VTOOL (scule aschietoare virtuale) cu aplicaţii în fabricatia palelor de elicopter. Programul software este realizat cu ajutorul limbajului de programare Visual Basic şi a sistemului CAD / CAM PoweShape / PowerMill de la Delcam.

ABSTRACT
The paper presents an application which objective is to provide a software tool for the integrated engineering of the complex parts. Thus, the article is focused on the automatic determination of virtual cutting tools in three-axis milling process of sculptured pockets. The main objective of this article is development an software tool called VTOOL (Virtual cutting Tools) whith applications in helicopter blade manufacturing. The software program is achieved with the help of tools of development Visual Basic and CAD/CAM system PoweShape / PowerMill from Delcam.

KEYWORDS: constructive-technological feature, milling process, mould, helicopter blade, cutting tool

CUVINTE CHEIE: entitate constructiv-tehnologica, proces de frezare, matrita, pala de elicopter, scula aschietoare

1. INTRODUCTION

Concurrent engineering [1] recommends a production process according to which the conceptual development of products and the preparation of their manufacturing are performed in parallel. A lot of design methods and techniques, resumed in the concept of the Design for X (DFX) [2, 3] are used in order to implement concurrent engineering. X could be virtual manufacturing, assembly, environment or cost, generating the following concepts: Design for Manufacturing (DFM), Design for Assembly (DFA), Design for Environment (DFE) and Design for Cost (DFC).

Integrated engineering is a methodology that integrates design of product (CAD – Computer aided design) with process planning (CAPP – Computer aided process planning), manufacturing processes (CAM -computer aided manufacturing), maintenance and recycles associates.

This methodology take into consideration still from design stage the constraints of future stages of product cycle life, integrating quality aspects, costs, exigencies of final user etc.

Feature technology provides the integration of design and the subsequent applications such as engineering analysis, process planning, machining and inspection. Currently, the main views are focused on how to obtain application features, such as manufacturing features, from a product model, and CAD/ CAE/ CAPP/ CAM integration.

The constructive-technological feature (CTF) [3, 9] concept is defined as the following: “a constructive-technological feature is a geometric shape that has attached several minimal geometrical configurations for milling (MGCM) for each manufacturing operation (roughing, semi-finishing, finishing, rest-material) and a set of information regarding the cutting process, like as cutting strategy, NC files, etc”.

ECU-Virtual [9] (Complex Milling Feature – Virtual) is an integrated design tool focused on the helicopter blade manufacturing. Currently, this software tool is articulated around the following modules: topological analysis of geometrical features, virtual specification of the mean of production, assistance to the development of machining process and elaboration of the milling process.

Several studies are being developed to determine the parameters of the cutting tools for prismatic parts [4, 5, 6, 7, 8].

The paper is focused on determination of the optimal virtual cutting tools in three-axis milling process of sculptured pockets. The proposed algorithm is implemented in VTOOL software (Virtual cutting tools).

2. VIRTUAL DETERMINATION OF CUTTING TOOLS

A modern helicopter blade [3] consists of a glass/ carbon fibres spar, glass/ carbon skin, honeycomb or foam core and a leading edge protection skin from stainless steel or titan alloy. A helicopter blade is a complex product made from composite materials.

There are some steps to follow in order to make a helicopter blade: helicopter blade design, mould design, process planning, mould manufacturing and composite blade manufacturing.

The CAD model of the helicopter blade and the CAD model of the moulds were designed by constructive technological macro features (CTMF) using the CADEBM (Computer Aided Design of Helicopter Blade and Mould) software system [9].

A CTMF of helicopter blade mould is composed from some constructive technological features such as aerodynamic pocket CTF and a split surface CTF.

Based on an analysis of the geometrical features of a mould, VTOOL calculates the main parameters of the cutting tools. The software program is achieved with the help of tools of development Visual Basic and CAD/CAM system PoweShape / PowerMill from Delcam [10].

VTOOL contains three modules. The first module, called VTOOL R-F/p, determines the cutting tools for roughing and finishing machining of the plane surfaces. The second and the third module, determine the cutting tools for roughing machining for sculptured surface (VTOOL R/s), respectively for finishing machining of sculptured surface (VTOOL F/s). Each CTF of the blade mould is analysed by VTOOL software, in order to determine the optimal cutting tools, figure 2.

Usually, the cutting tools used in roughing milling process are toroid cutters or end mill cutters. Also, semi-finishing and finishing milling process uses toroid cutters or ball nose end mills.

As result of CTMF analysis, VTOOL proposes optimal cutting tools for the manufacturing of each CTF. Also, VTOOL calculates the MGCM (minimal geometrical configuration for milling) of cutting tools. Then, VTOOL systems allows the automatic generation of optimal cutting tools in PowerMill environment.

The concept of MGCM [9] allows rapid specification of optimum cutting tools used to machining a constructive technological feature. In the context of the integrated design, the MGCM concept allows informing the designer about the machinability of the part from a cutting tool point of view, or allows informing the CNC (Computer numerical control) programming engineer about the optimal cutting tool that can be chose for machining a feature of a part.

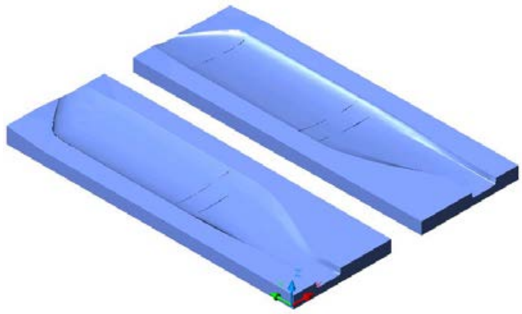


Figure 1: *CAD model of a helicopter blade mould*

The input data for VTOOL software are 3D CAD models in neutral file format, such as IGES or STEP. The first step supposes to import the IGES file in PowerShape [10] and analyse the NURBS surfaces of each component CTF.

Then, the main parameters of the cutting tools for roughing milling and finishing milling are determined. Based on the geometrical parameters, the cutting tools are automatically generated in PowerMill environment. The algorithm used to determine the parameters of the cutting tools is presented in the figure 3 for roughing milling process, respectively figure 4 for the finishing milling process.

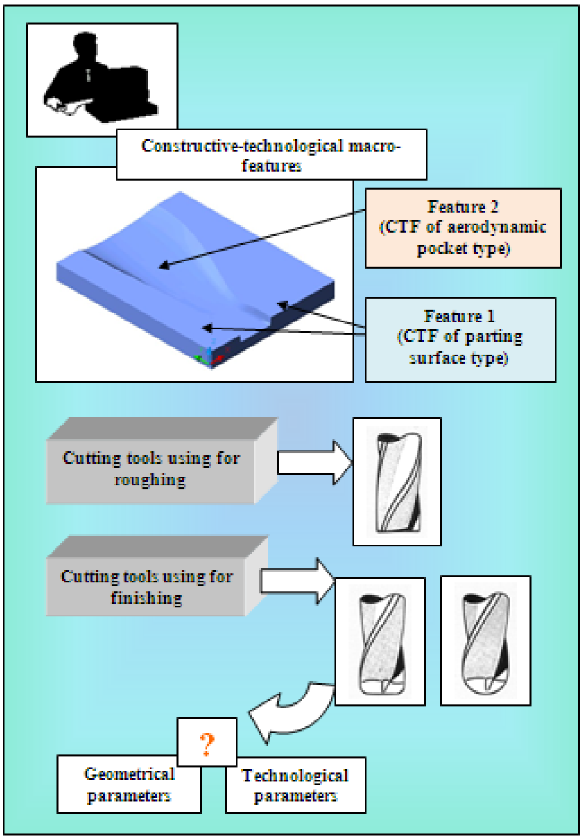


Figure 2*: Virtual determination of cutting tools in milling process*

VTOOL R/s and VTOOL F/s modules were written in Visual Basic programming language, based on the algorithms presented in figure 3 and 4.

Briefly, VTOOL R/s uses the following procedure:

- analysis of IGES model;
- automatic calculation of cutting tool parameters (MGCM);
- determination of the optimum diameter of cutting tools.

VTOOL F/s proposes the following procedure:

- analysis of the model surfaces. The NURBS surfaces are transformed in PowerSurface. PowerSurface is a specific surface used in PowerShape environment, define from a isoparametric network of longitudinal and lateral curves;
- determination of the minimum radius of curvature of the surface;
- automatic definition of the optimal virtual cutting tool (ball nose end mill or tip radius tool), taking into accord the normalized tool radius from tools catalogues.

The user has the possibility to choose between a ball nose end mill tool or a tip radius tool. It is recommended to use a tip radius tool because this is more robust and productive than ball nose end mill tool.

3. CASE STUDY

A constructive technological macro-feature of a helicopter blade mould, see figure 1, was analysed using VTOOL software.

VTOOL R/s has determined and defined two end mill cutters for roughing process. The first tool is a 16 mm in diameter and the second one has a diameter of 8mm. The second tool is used for rest-roughing.

Rest-roughing allow the optimising the roughing process by machining, using a smaller tool, of the job areas that could not be accessed by the first large tool.

Two ball nose cutters was determinate using the VTOOL F/s software. The first tool, having 6mm in diameter is used for finishing and the second having 1mm in diameter is used for rest-finising. Rest-finishing, using a smaller tool is limited to local areas that were inaccessible to a previous larger tool.

Finally, based on the above results were chosen the optimum cutting milling tools, and then automatically, all these virtual cutting tools were generated within PowerMill environment.

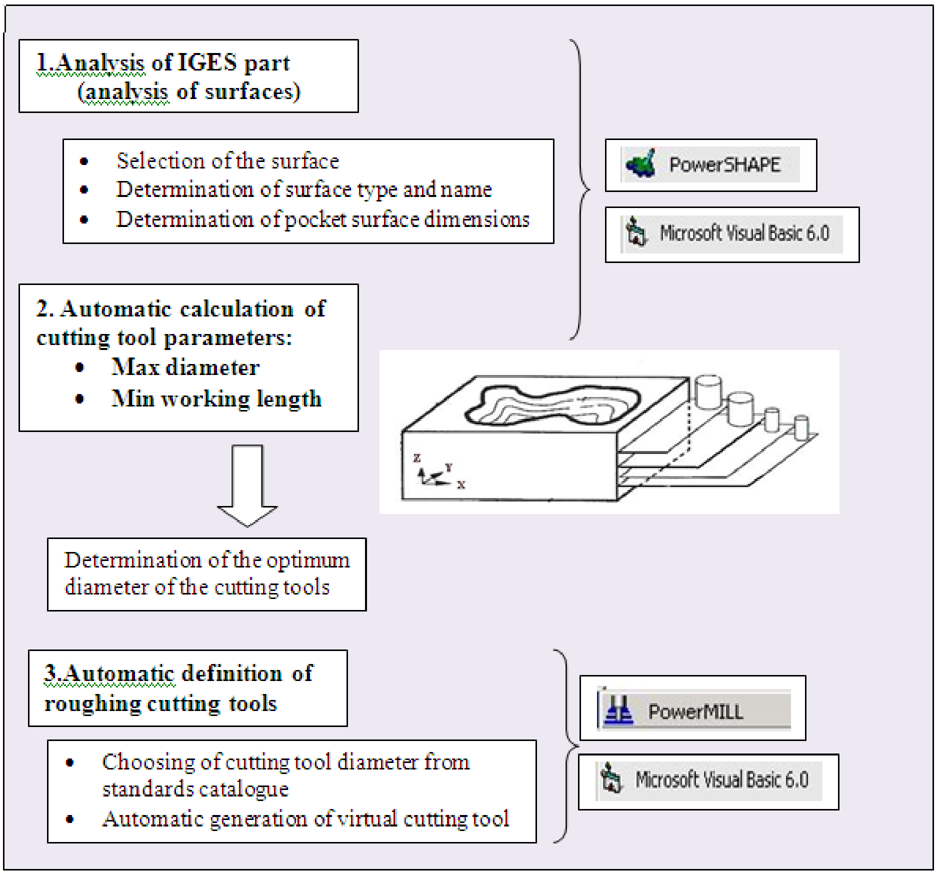


Figure 3*: Virtual determination of cutting tools in roughing milling process of sculptured pocket*

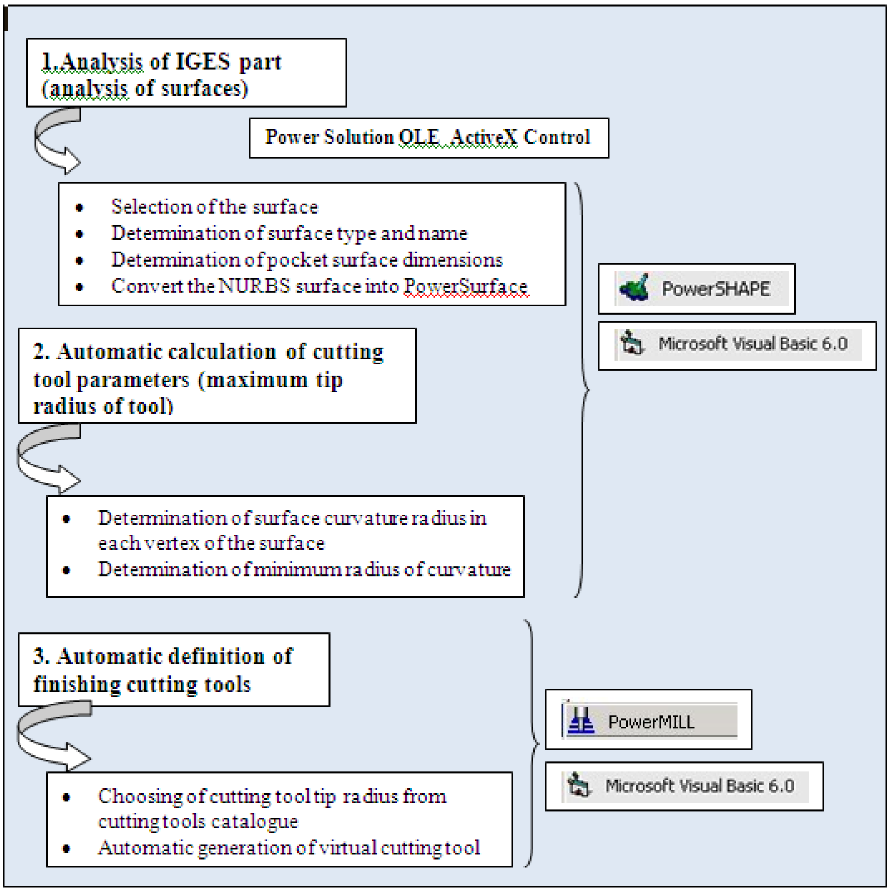


Figure 4: *Virtual determination of cutting tools in finishing milling process of sculptured pocket*

4. CONCLUSIONS

Usually, the cutting tools geometrical parameters are chosen based on measurements on the CAD model surfaces. Traditionally, this job is realized in manual way by a CNC programmer engineer.

This article proposes an algorithm which was implemented in a software tool, that specify in automatically way, the production resources, in particular the determination of main parameters of milling cutting tools and automatic generation of cutting tools. VTOOL software is a DFX tool, focused on the determination of optimal cutting tools used in three axis milling process of sculptural pockets. The software program is achieved with the help of tools of development Visual Basic and it is implemented within the commercial CAD/CAM system PoweShape / PowerMill of Delcam. However, there are still problems to be solved by future research such as the determination of optimal cutting tools in five axes milling machining of sculptural surface.

REFERENCES

[1]. **Machover, C.**, *"The CAD/CAM handbook"*, McGraw Hill, USA, 1996

[2]. **Huang, G., Q., Lee, S.,W., Mak, K., L.**, *"Web-based product and process data modelling in concurrent design for X"*, Robotics and Computer-Integrated Manufacturing, 15, 53-63, 1999.

[3]. **Udroiu, R.,** *"Design and manufacturing of complex parts"*, PhD thesis, Transilvania University of Braşov, 2003.

[4]. **Mawussi, K**., **Duong, V.H.**, **Ponsonnete, R**., *"Determination of virtual means for the integrated design"*, Integrated Design and Manufacturing in Mechanical Engineering, 323-330, 2002.

[5]. **Elmesbahi, A., Rechia, A., Jaider, O., "***Optimized-automated choice of cutting tool machining manufacturing features in milling process"*, 11th World Congress on Computational Mechanics, 33-42, 2014.

[6]. **Osman Z.M.N., Case, K. and Watts, D.,** *"Cutting tools in finishing operations for CNC rapid manufacturing processes: simulation studies"*, Proceedings of the Twelfth International Conference on Manufacturing Research, Southampton: Hampshire Press Ltd. 163 – 168, 2014.

[7]. **Zhou, X., Qiu, Y., Hua, G., Wang H., Ruan, X., "***A feasible approach to the integration of CAD and CAPP"*, Computer-Aided Design 39, 324–338, 2007.

[8]. **Suresh Kumar Reddy N., Venkateswara Rao, P., "***Selection of optimum tool geometry and cutting conditions using a surface roughness prediction model for end milling"*, Int J Adv Manuf Technol 26: 1202–1210, 2005.

[9]. **Udroiu, R.,** *"Integrated design and manufacturing system for blades mould"*, Annals of DAAAM for 2008 & Proceedings of the 19th International DAAAM Symposium, 1417-1418, 2008.

[10]. Delcam - Complete CADCAM Software Solutions, http://www.delcam.com/, 2010.

CNC MILLING OF SPIRAL SHAPE CONTOURS USING FACS-15 SOFTWARE SYSTEM

Camil Lancea

Transilvania University of Brasov, Brasov, ROMANIA, camil@unitbv.ro

REZUMAT

Orice gen de prelucrare prin așchiere, dar nu numai, a pieselor, suprafețelor sau contururilor trebuie realizată astăzi prin utilizarea unor tehnici moderne, în regim asistat de calculator. Altfel spus, orice prelucrare modernă presupune utilizarea unor echipamente de tip CAD/CAPP/CAM/CAE. În concordanță cu noile concepte de inginerie, precum ingineria modelării și simulării, toate informațiile aferente fazei de modelare geometrică (CAD) trebuie memorate în vederea accesării lor atât în faza proiectării tehnologice (CAPP) cât și în faza mașinării (CAM).

Lucrarea prezintă un pachet software a cărui interfață oferă o serie de facilităţi, atât in faza de proiectare a contururilor cât şi în faza de fabricaţie a acestora, rezultate din automatizarea celor două procese. Acest lucru este posibil prin folosirea unor configurații geometrice predefinite, originale. Aceste configurații geometrice, din cunoștințele noastre, nu pot fi generate automat de niciun alt pachet CAD/CAPP/CAM/CAE existent pe piață.

Pachetul software permite, de asemenea, modificarea dinamică a elementelor geometrice ce definesc aceste contururi în cadrul fazei CAD. Alte avantaje ale acestui sistem vizează proiectarea comenzilor în limba română precum și prețul de achiziție avantajos, comparativ cu cel al unor sisteme consacrate, de tip CAD/CAM/CAE, destinate proiectării și mașinării CNC, prin frezare, precum CATIA, ProEngineer, Solid Works, Power Mill etc.

ABSTRACT

Any kind of chip removing process, but not only, of the parts, surfaces or contours must be done today by using modern techniques that implies the use of computer-aided systems. In other words, any modern machining process involves the use of CAD / CAPP / CAM / CAE equipment. In accordance with the new concepts of engineering, as modelling engineering and simulation engineering, all related information with the geometric modelling phase (CAD) must be saved in order to access them both within the process planning phase (CAPP) and in the manufacturing phase (CAM).

This paper presents a software package whose interface provides a number of facilities, both in the contours design phase and in its manufacturing phase, resulting by the automation of both processes. This is possible by using original default CAD geometries. These geometric configurations, in so far as we know, cannot be generated automatically by any other CAD / CAPP / CAM / CAE software from the market.

The software package also allows, within the CAD phase, to modify quickly the shape of the elements that defines the contours. Other advantages of this system refers to the Romanian language commands and also the favourable purchase price, compared to other similar CAD / CAM / CAE CNC milling systems, such as: CATIA, Pro Engineer, Solid Works, Power Mill etc.

KEYWORDS: CAD, CAPP, CAM, Software, CNC Milling, Spiral Shape Contours, Optimizing

CUVINTE CHEIE: CAD, CAPP, CAM, Soft, Frezare CNC, Contururi în spirală, Optimizare

1. INTRODUCTION

Nowadays one of the problems of small size companies and sometimes even medium-sized companies is represented by the impossibility of purchasing hardware equipment and software systems due to the limited budget.

The present paper suggests a solution, targeting the software side of the problem, through the acquisition

of a CAD optimized system instead of a CAD/CAPP/CAM system.
The CAD system optimization refers to its programming, in order to transform it into a CAD/CAP/CAM system, which is able to provide optimal solutions to particular circumstances. The particular situations, presented in this paper, refers to the processing of spiral contours and are an addition to those presented in a previous work [4] where it was being treated the manufacturing of closed contours.
The presented software is called FACS-15 (Frezarea Asistată a Contururilor Spirale - 2015 – NC Milling of Spiral Contours - 2015). This system has a data base composed of a series of predefined contours, with spiral geometries, that can be quickly changed [6, 7].
The user has the possibility to change both contour dimensions and shape.
The system was created by using the AutoCAD, VisualLISP and DCL programming language as basic software and runs under any version of AutoCAD software that is higher that AutoCAD R12.

2. SOFTWARE MODULES [4]

The software structure is similar with the previous presented software [4] and is composed of five different modules (figure 1):

- FACS-Input: (data input);
- FACS- Geometry: (profile generation);
- FACS- Processing: (CAPP phase);
- FACS-Simulation (manufacturing simulation);
- FACM- Manufacturing (NC programm).

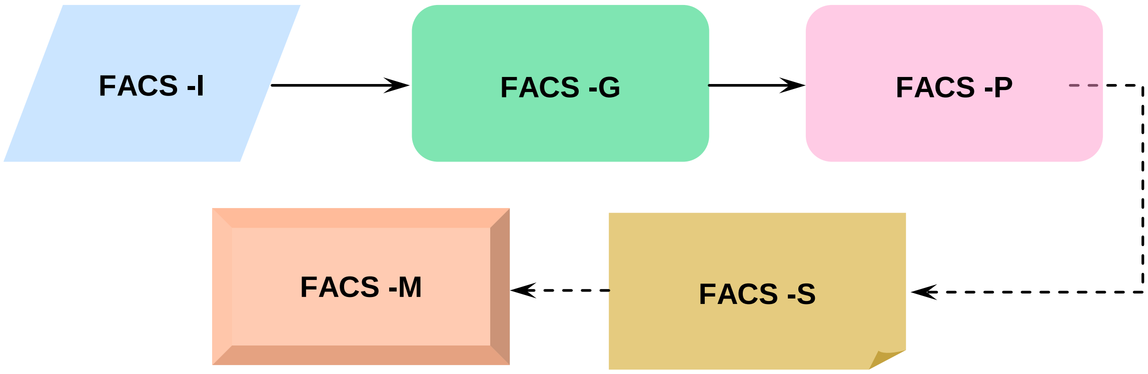


Figure 1: *FACS-15 modules*

3. SOFTWARE INTERFACE

The FACS-15 interface (Fig. 2) presents the software menus [4]. Each menu contains a set of commands which can be used for solving different problems such as file operations (open, close, save etc.), CAD commands (line, circle, spline etc.), CAM procedures (manufacturing possibilities), simulations or help.

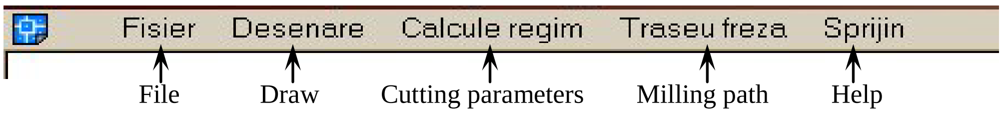
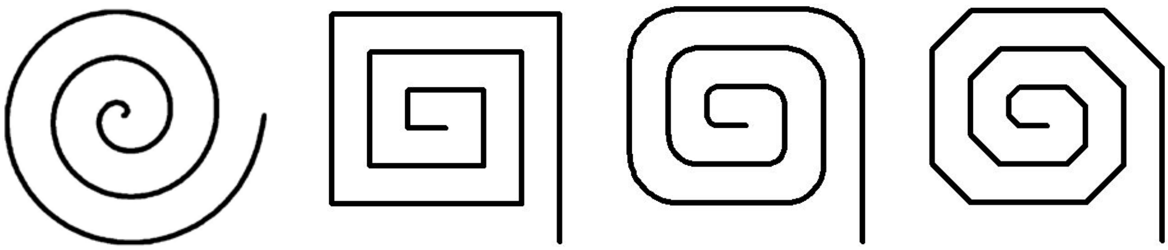


Figure 2: *The FACS-15 interface*

4. FACS-I MODULE

For designing the contour, FACS-15 program has 4 different predefined spiral contours (Fig. 3):

- an Archimedean spiral (Fig. 3-a);
- a rectangle spiral (Fig. 3-b);
- a rounded rectangle spiral with constant or variable fillet radius (Fig. 3-c);
- a chamfered rectangle spiral with constant or variable chamfer(Fig. 3-d);



a – Archimedean spiral; b – rectangle spiral; c – rounded rectangle spiral; d – chamfered rectangle spiral;
Figure 3: *Predefined spiral contours*

To choose the desired contour a dialog window is displayed with four different buttons for each kind of contour (Fig. 4).

Figure 4: *Contours dialog window*

5. FACS-G MODULE

The FACS-15 software [5] offers the possibility to generate four different spiral contours as follows:

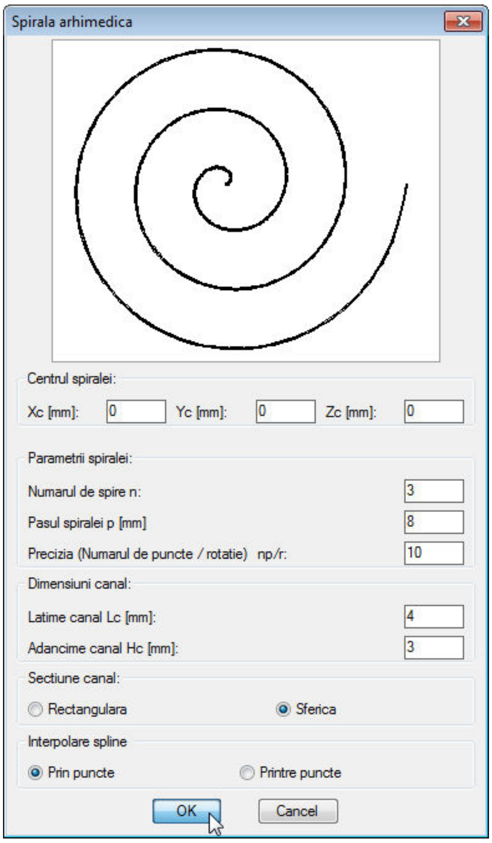


Figure 5: *Archimedean spiral dialog box*

The Archimedean spiral has a very simple mathematical relation [1], in polar coordinates (r, θ), it can be described by the equation:

$$r = \mathrm{a} + \mathrm{b}\theta \tag{1}$$

where a and b can be any real numbers.

To define the Archimedean spiral by using the FACS-15 software the following input data are needed (Fig. 5):

- the coordinates of the spiral centre;
- the number of rotations;
- the spiral pitch;

5.1 Archimedean spiral contours (Fig. 5)

- the spiral precision defined by the number of points which describe a 360 degree rotation (Fig. 6);

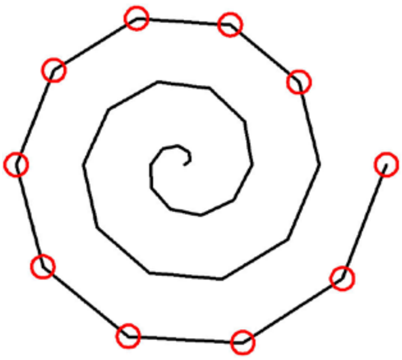


Figure 6: Spiral precision *(10 points)*

- the contour section dimensions, given by its width and height (Fig. 7);
- the contour section shape: rectangular or spherical; (Fig. 7)

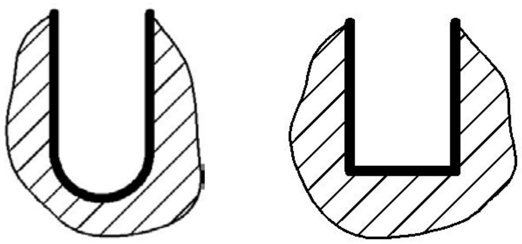
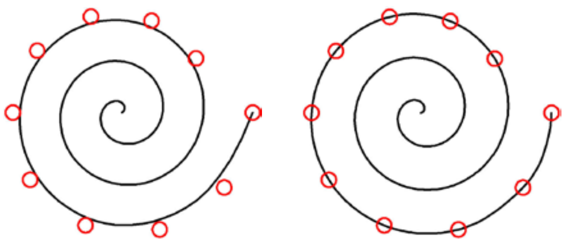


Figure 7: *Contour section*

- the interpolation type [3]: spline or fit (Fig. 8)



a – spline *b – fit*

Figure 8: *Interpolation type*

5.2 Rectangle spiral contours (Fig. 9)

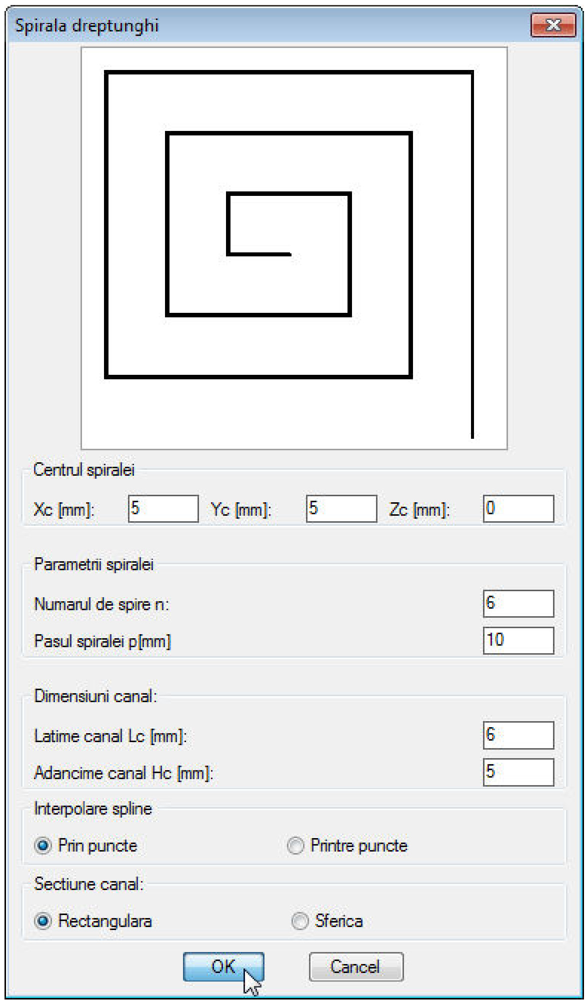


Figure 9: *Rectangle spiral dialog box*

The rectangle spiral contour is defined very similar to the Archimedean spiral contours by filling the input data of the rectangle spiral dialog box.

5.3 Rounded rectangle spiral contours (Fig. 10)

The rounded rectangle spiral contours are defined also very similar to the Archimedean spiral contours by filling the input data of the rounded rectangle spiral dialog box. In this case a new parameter appears: the fillet radius.
The fillet radius was defined in two different ways as follows:

- a constant radius along the entire profile, in this case the input data refers to the radius dimension value;
- a variable radius along the entire profile, in this case the input data refers to the first radius dimension value (which is the smallest one) and a multiplication factor, F, which is used to

calculate the next filet radius as follows (Fig. 11):

$$r_{i+1} = r_i \cdot F \quad (2)$$

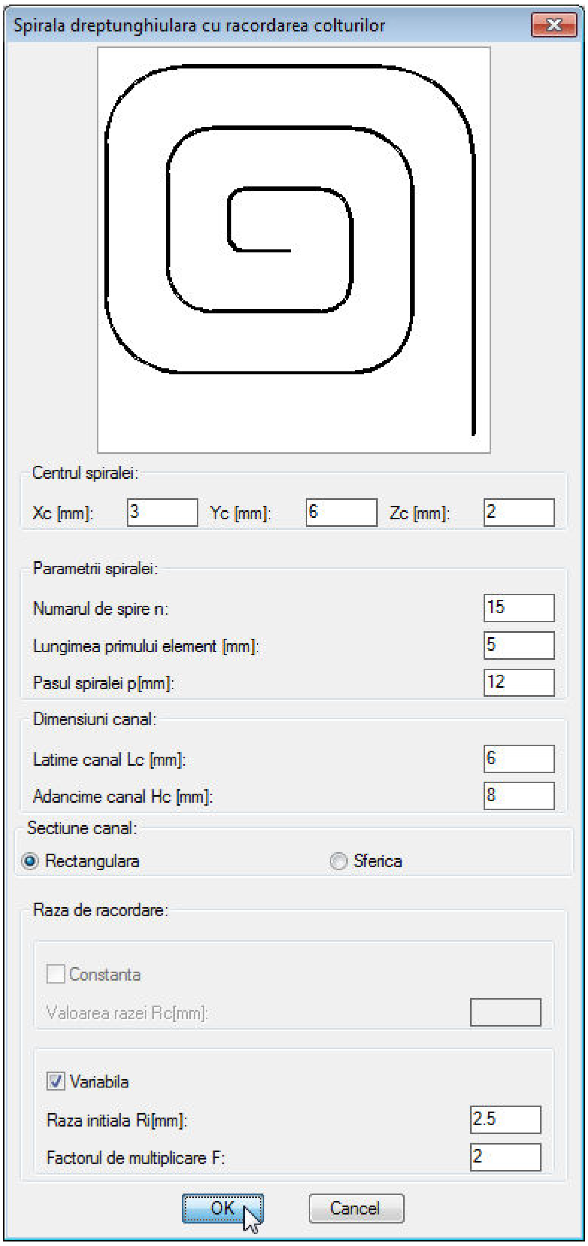


Figure 10: *Rounded rectangle spiral dialog box*

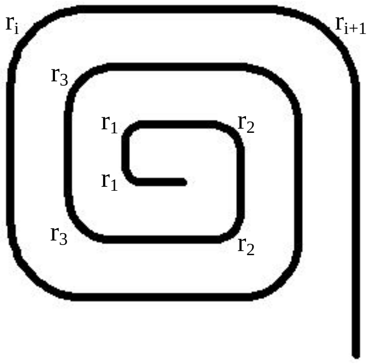


Figure 11: *Rounded rectangle spiral with variable radius*

5.4 Chamfered rectangle spiral contours (Fig. 12)

The chamfered rectangle spiral contours are defined also very similar to the rounded spiral contours by filling the input data of the rounded rectangle spiral dialog box. In this case a new parameter appears: the chamfer value.

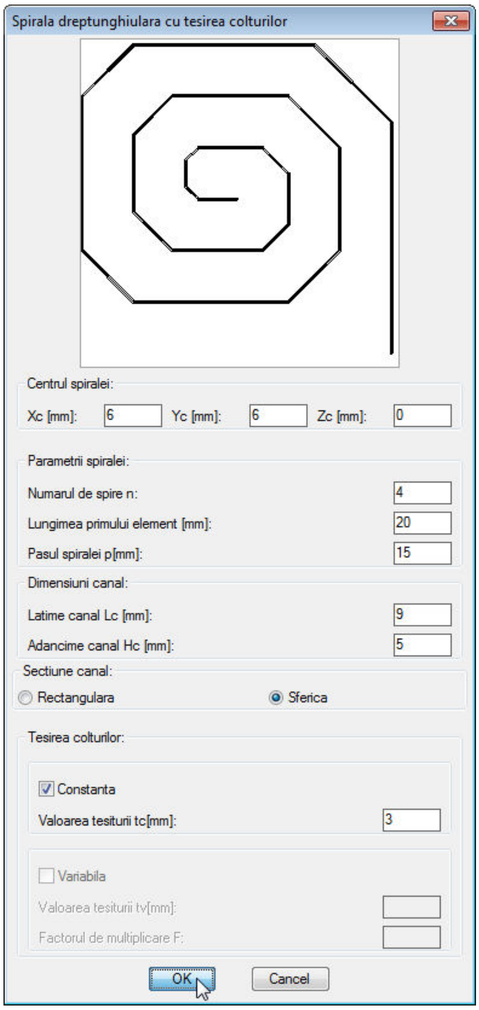


Figure 12: *Chamfered rectangle spiral dialog box*

The chamfer value was defined in two different ways as follows:

- a constant chamfer along the entire profile, in this case the input data refers to the chamfer dimension value;
- a variable chamfer along the entire profile, in this case the input data refers to the first chamfer dimension value (which is the smallest one) and a multiplication factor, F, which is used to calculate the next chamfer value as follows (Fig. 13):

$$t_{i+1} = t_i \cdot F \qquad (2)$$

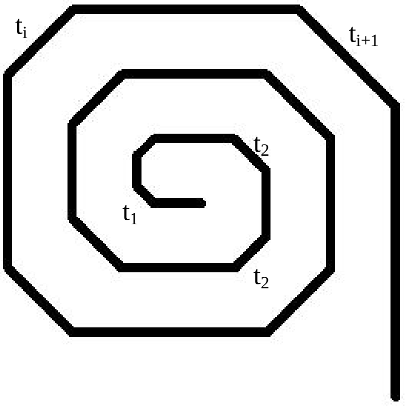


Figure 13: *Rounded rectangle spiral with variable radius*

5. THE FACS-P MODULE [4]

Within the FACS-P module all the machining parameters [2] and machining precision will be computed after inserting all the information about:

- the tool;
- the billet material;
- the cutting depth;
- the manufacturing precision,

as shown in figures 14 and 15.

The manufacturing precision can be chosen by using one operation (roughing or finishing) or both.

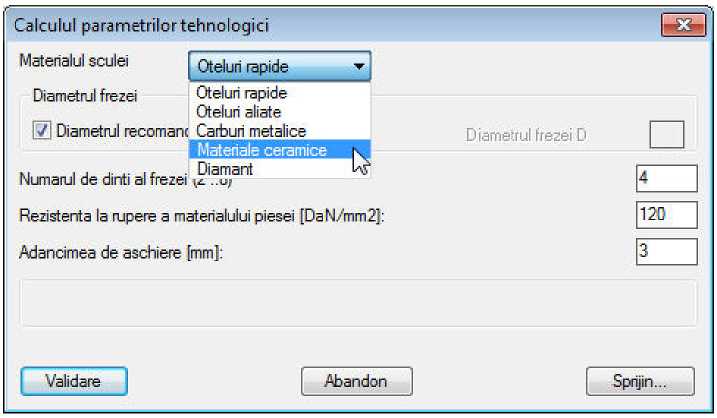


Figure 14: *Input data for the machining parameters*

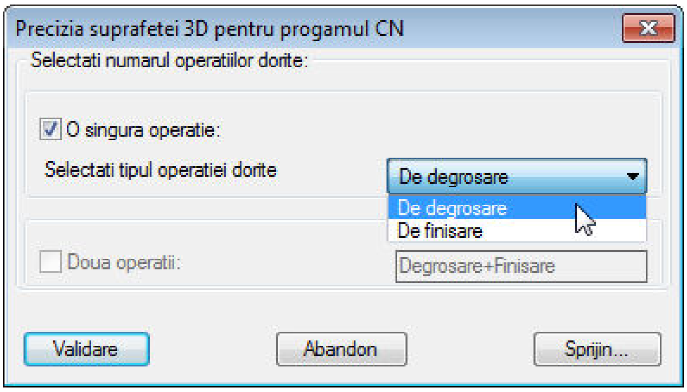


Figure 15: *Input data for the surface precision when using a single operation*

7. FACS-M MODULE

When all parameters were calculated the system starts the procedure for generating the CNC program for manufacturing.

For a better management of the CNC programs, the software gives the possibility to insert different comments, at the beginning of each CNC program (Fig. 16).

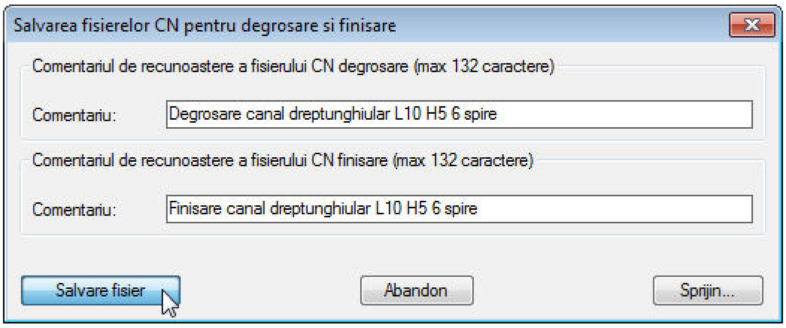


Figure 16: *NC program generation for roughing and finishing operations*

CONCLUSIONS

The FACS-15 software was created in accordance with simultaneous engineering concepts and can be very useful for Romanian companies interested in the design and manufacturing of spiral contours. Some of the software benefits for the Romanian firms are:

- the user-computer dialog is in Romanian language and the software has also a Romanian help section;
- the software can be used with a low price software (AutoCAD R12).
- the software has an original mathematical algorithm which automatically generates the contour geometry and the paths for roughing and finishing phases;

REFERENCES

[1]. **Darling, D.** "*The Universal Book of Mathematics: From Abracadabra to Zeno's Paradoxes*", John Wiley & Sons Inc., pp. 20, ISBN: 0-471-27047-4.

2]. **Galvez, A., Iglesias, A.**, "*From Nonlinear Optimization to Convex Optimization through Firefly Algorithm and Indirect Approach with Applications to CAD/CAM*", Scientific World Journal, The Scientific World Journal, vol. 2013, Article ID 283919, 10 pages, doi:10.1155/2013/283919, ISSN: 1537-744X. 2013.

[3]. **Kumar, R., Baskar, S.** "*B-spline quasi-interpolation based numerical methods for some Sobolev type equations*", Journal of Computational and Applied Mathematics, Volume: 292, January 2016, p. 41-66, ISSN: 0377-0427, eISSN: 1879-1778.

[4]. **Lancea, C.**, "*CNC Milling Of Closed Contours Using Faci-13 Software System*", Tehnologia Inovativa Journal, ISSN 2248 - 0420; pp. 21-26, ISSN-L 2248 – 0420, Anul 65, Nr. 3-4 / 2013.

[5]. **LANCEA, C.**, "*CAD Solutions for NC Milling - FACS-2000 Software*", The 1st International Conference on Computing and Solutions in Manufacturing Engineering - CoSME'04, Braşov-Sinaia, Universitatea TRANSILVANIA din Braşov, p. 198-201, ISBN 973-635-373-7, 2004.

[6]. **Vrsek, J., Miroslav, L.** "*Reducibility of offsets to algebraic curves*", Computer Aided Geometric Design, Vol. 30, Issue 1, January 2013, p. 140-147, ISSN 0167-8396

[7]. **Zhao,X., Zhang, C., Yang, B., Li P.**, "*Adaptive knot placement using a GMM-based continuous optimization algorithm in B-spline curve approximation*", Computer Aided Design Journal, vol. 43, no. 6, pp. 598–604, ISSN: 0010-4485, 2011.

CERCETĂRI PRIVIND ÎMBINAREA PRIN VULCANIZARE A BENZILOR PENTRU TRANSPORTOARE/ RESEARCH REGARDING OF THE BELT CONVEYORS JOINT VULCANIZATION

Vlad-Alexandru Florea

University Petroşani, 20 University Street, 332006, Petrosani, România

REZUMAT
Benzile din cauciuc ale instalaţiilor de transport sunt supuse unor permanente fenomene de uzură, iar menţinerea lor în exploatare, peste o anumită limită de utilizare devine sursa principală de opriri şi întreruperi în funcţionare a întregului flux tehnologic din care fac parte. Este necesar de subliniat că banda are cel mai ridicat cost dintre cele ale elementelor ce compun o instalaţie de transport ceea ce justifică interesul ce trebuie manifestat faţă de acţiunile de mentenanţă care trebuie efectuate, mai cu seamă pentru prelungirea duratei lor de viaţă. Când straturile de protecţie din cauciuc au atins un grad de uzare care pune în pericol structura de rezistenţă (inserţiile textile, respectiv din cabluri de oţel), una din principalele măsuri destinate prelungirii duratei totale de utilizare a benzilor este vulcanizarea corectă a acestora.

ABSTRACT
Rubber belt of the transport installations are subject to permanent wear phenomena and keeping them in operating above a certain limit of use becomes the main source of stops and interruptions in functioning of the whole technological flow they belong to. It is necessary to note that the belt has the highest cost of the elements that compose a transport installation which justifies the interest that must be manifested for the maintenance actions to be carried out, especially for their lifetime extension. When rubber coating have attained a degree of wear which endangers the resistance structure (textile inserts respectively steel cable) one of the main measures for extending the total duration of use of the belts is their correct vulcanization.

KEYWORDS: rubber belts, belt conveyors, joint systems, vulcanization

CUVINTE CHEIE: benzi de cauciuc, transportoare cu bandă, sisteme de îmbinare, vulcanizare

1. INTRODUCERE/INTRODUCTION

Operaţia de recondiţionare a benzilor constă în refacerea straturilor de cauciuc, respectiv a inserţiilor deteriorate, precum şi aducerea lor la dimensiunile de fabricaţie iniţiale. O astfel de operaţie este precedată de o serie de activităţi care, în principal, au drept scop pregătirea structurii de rezistenţă a benzilor. Recondiţionarea benzilor pentru transportoare şi importanţa ce o reprezintă aceasta pentru reducerea costurilor de exploatare suportate de agenţii economici reiese din numărul mare de benzi aflate în funcţiune la unele unităţi miniere cu exploatare la zi. Efortul financiar care trebuie făcut de către unităţile respective, la fiecare patru ani, cât este durabilitatea medie a benzii este deosebit de mare.

Vulcanizarea benzilor pentru transportoare este principalul procedeu pentru îmbinarea lor şi ca urmare fiabilitatea lor influențează întregul flux tehnologic al unei exploatări.

Durabilitatea îmbinării prin vulcanizare la cald a benzilor depinde de aderenţa obţinută, între suprafeţele de îmbinare. Hotărâtor pentru obţinerea unor valori ale rezistenţei îmbinării care să se apropie cât mai mult de rezistenţa nominală a benzii propriu-zise, este dimensionarea corespunzătoare a lungimii de vulcanizare şi a treptelor de îmbinare.

Lungimea de îmbinare, numărul de trepte şi lungimea lor sunt determinate de tipul constructiv al benzii, numărul de inserţii (fig. 1) şi calitatea acestora.

Sistemul de îmbinare a benzilor cu inserţii din cabluri de oţel este determinat de diametrul cablurilor şi distanţa dintre ele. Aceasta înseamnă că atunci când diametrele cablurilor sunt mici, distanţa dintre cabluri sau pasul acestora va fi mare, iar cablurile corespondente, de la ambele capete de bandă, se vor întrepătrunde. Acest sistem de aşezare al cablurilor este cunoscut sub denumirea de îmbinare a benzilor într-o singură treaptă şi este aplicabil în Romania următoarelor tipuri de benzi cu cabluri de oţel: ST 800, ST 1000 şi ST 1600, lungimea de îmbinare fiind de 650, 700 şi 900 mm; benzile din clasele de rezistenţă ST 1250, ST 2000, ST 2500, ST 3150 şi ST 5000 se îmbină în două trepte, conform figurii 2.

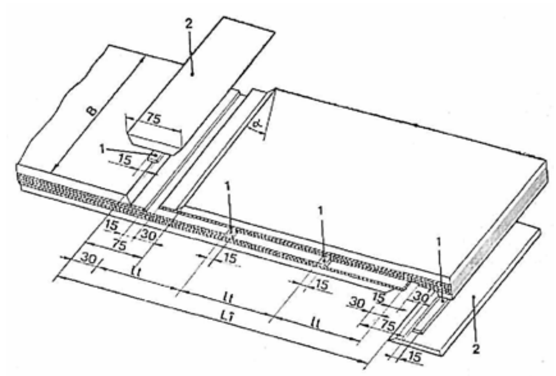


Figura 1. *Cotele de lucru în vederea îmbinării prin vulcanizare la cald a unei benzi de transport cu 4 inserţii [1]:*
1 - fâşii de plastic pentru umplerea rostului dintre inserţii; 2 – suprafaţă de îmbinare;
l_t - lungimea unei trepte de îmbinare; L_i - lungimea de îmbinare prin vulcanizare; α - unghiul de înclinare al treptelor de îmbinare; B-lăţimea benzii

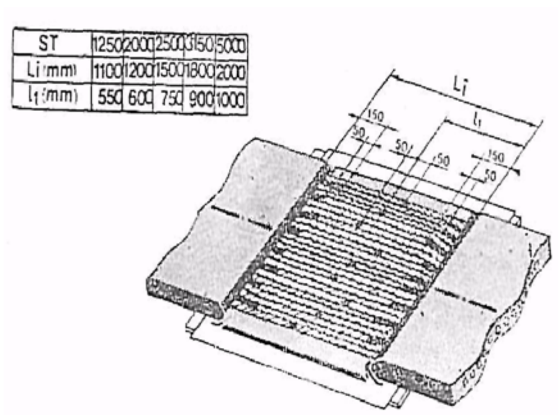


Figura 2. *Sistemul de îmbinare al benzilor în două trepte [1]*
L_i - lungimea de îmbinare; l_i - lungimea treptei de îmbinare

Alegerea modului de îmbinare depinde de clasa de rezistenţă a benzii, astfel încât transmiterea corectă a forţelor de tracţiune de către zona de îmbinare, se realizează prin dimensionarea corespunzătoare a lungimii treptelor.

În literatura de specialitate [2] există puţine date privind rezultatele cercetărilor întreprinse pentru a găsi soluţiile de îmbunătăţire a calităţii îmbinărilor prin vulcanizare a benzilor, toate fiind caracteristice unor structuri de material cu aplicaţii limitate.

Productivitatea unui transportor cu bandă depinde în mare măsură, de timpul de staţionare necesar efectuării reparaţiilor şi în special al refacerii îmbinărilor sau al înlocuirii unor tronsoane de bandă.

2.TEMPERATURILE CA FACTOR DE INFLUENŢĂ ÎN PROCESUL DE VULCANIZARE

Vulcanizarea prin încălzirea electrică a zonei de îmbinare a benzilor (cu inserţie textilă, sau cu cabluri de oţel) se realizează cu ajutorul unor instalaţii (fig. 3), care se caracterizează prin:

- distribuirea uniformă a forţelor de apăsare pe capetele de bandă (pe toată suprafaţa de vulcanizat);
- inerţia termică mică datorată plăcilor termice realizate din aliaje de aluminiu;
- transferul energiei termice este ridicat, iar consumul de electricitate este mic (prin controlul timpilor de vulcanizare).

Factorii care influenţează procesul de vulcanizare a benzilor de cauciuc sunt:

- temperaturile de încălzire;
- forţa de apăsare a capetelor benzilor care urmează a se îmbina;
- timpii de vulcanizare.

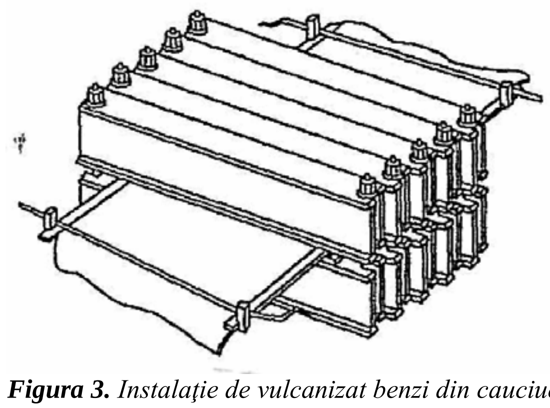


Figura 3. *Instalaţie de vulcanizat benzi din cauciuc [1]*

În procesul de vulcanizare a benzilor din cauciuc, o importanţă deosebită pentru materialele implicate o are conductivitatea lor termică [3], [4], [5].

În cazul transferului termic (conform legii lui Fourier), de la placa de încălzire a instalaţiei de vulcanizare spre cauciucul din bandă, densitatea fluxului de căldură q_s ia forma:

$$q_s = -\lambda \frac{dt}{dx} \pm \lambda_l \frac{dt}{dx} \text{ [W/m}^2\text{]} \quad (1)$$

în care: dt/dx este gradientul de temperatură după direcţia x a fluxului; λ_l – conductivitatea termică datorată agitaţiei termice a particolelor de material.

Ecuaţia diferenţială a conductibilităţii printr-un volum material se exprimă sub forma:

$$\rho c \frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}\left(\lambda_x \frac{\partial \theta}{\partial x}\right) + \frac{\partial}{\partial y}\left(\lambda_y \frac{\partial \theta}{\partial y}\right) + \frac{\partial}{\partial z}\left(\lambda_z \frac{\partial \theta}{\partial z}\right) \quad (2)$$

unde: θ este temperatura; λ conductivitatea termică; c căldura specifică; ρ densitatea, t timpul; x, y, z variabile independente ce stabilesc poziţia unui punct M din volumul de material care are temperatura θ.

Pe măsură ce căldura se transmite prin banda supusă vulcanizării, temperatura în diferitele sale puncte se modifică, dar cantitatea de căldură rămâne aceeaşi.

Pentru o sursă plană de căldură, dispusă în planul Oyz, variaţia temperaturii θ(x,t), în lungul axei Ox se determină cu relaţia:

$$\theta(x,t) = \frac{q \cdot t}{\rho \cdot c \cdot (4 \cdot \pi \cdot a \cdot t)^{1/2}} e^{-\frac{x^2}{4 \cdot a \cdot t}} \quad (3)$$

unde: $a = \dfrac{\lambda}{\rho \cdot c}$; q este densitatea fluxului de căldură (de la sursă);

Pentru detrminarea teoretică a temperaturilor în timpul încălzirii de la sursa sub formă de placă din aliaj de aluminiu, s-au luat în considerare următoarele mărimi: c=794,2 [J/(kg·K)], ρ=3980 [kg/m^3], λ=38,9 [W/(m·K)], q=238,5·10^3 [W/m^2].

Tabelul 1. *Valorile temperaturilor in funcţie de timp*

Grosimea zonei încălzite			
x=6 [mm]		x=24 [mm]	
timp [min]	temperatura [°C]	timp [min]	temperatura [°C]
65	105,83	65	106,90
66	108,73	66	109,79
67	111,63	67	112,67
68	114,47	68	115,52
69	117,31	69	118,35
70	120,13	70	121,16

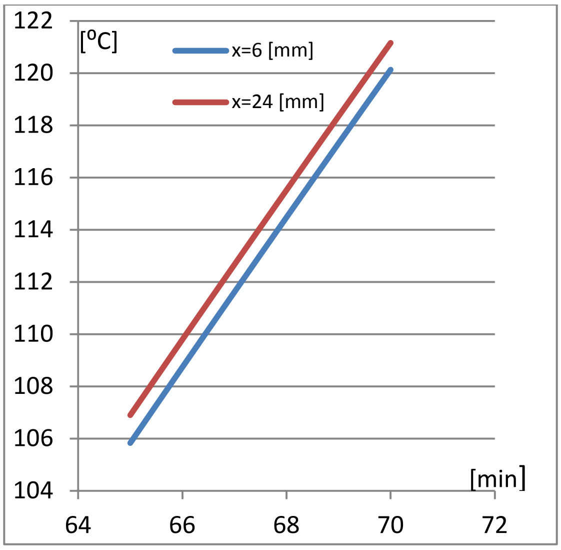


Figura 4. *Variaţia temperaturii de încălzire în funcţie de timp, pentru două grosimi ale benzii.*

Variaţia temperaturilor calculate pentru diferite durate de încălzire a benzii, în instalaţia de vulcanizat, sunt cuprinse în tabelul 1 şi sunt reprezentate grafic în figura 4.

Valorile temperaturilor calculate, cuprinse în tabel, pentru intervalul de încălzire cuprins între 65 si 70 minute corespund cu cele măsurate practic, în procesul real de vulcanizare. Acest aspect, adică respectarea timpilor de încălzire concomitent cu temperaturile corespunzătoare, ca şi găsirea soluţiilor de micşorare a deformaţiilor constatate la unele traverse ale instalaţiilor de vulcanizat pot contribui la obţinerea de îmbinări cu calităţi superioare, respectiv la reducerea întreruperilor în funcţionare a transportoarelor cu bandă.

3. SOLUŢII DE ÎMBUNĂTĂŢIRE A COMPORTĂRII ÎN EXPLOATARE A INSTALAŢIILOR DE VULCANIZARE A BENZILOR

Tehnologia de îmbinare ca şi echipamentul utilizat influenteaza obţinerea rezistenţei la tracţiune şi a structurii corespunzatoare, în porţiunea de îmbinare a benzilor care trebuie să fie cât mai apropiate de rezistenţa şi structura lor nominală. Inserţia de metal, respectiv dispunerea cablurilor, în zona de îmbinare, prezintă importanţă deosebită deoarece acestea asigură rezistenţa mecanică a secţiunii benzii.

Cunoaşterea şi respectarea operaţiunilor de executare a îmbinării sunt condiţii absolut necesare pentru vulcanizarea corespunzătoare a benzilor. În acelaşi timp, elementele componente ale instalaţiilor de vulcanizat, în special traversele, trebuie să fie supuse unor solicitări şi deformaţii limitate care să nu influenţeze calitatea îmbinărilor benzilor.

În componenţa instalaţiei de vulcanizare tip IVB (fig. 5), intră mai multe subansamble și anume:

- plăcile de vulcanizare care generează căldura necesară procesului de vulcanizare;
- încălzirea electrică este asigurată de rezistențe amplasate în tuburi metalice, astfel încât să se obţină o repartiţie uniformă a temperaturii;
- unităţile de presiune, fiecare fiind formată dintr-o traversă superioară şi o traversă inferioară, fixate la capete cu şuruburi; traversa superioară este echipată cu cilindri hidraulici, alimentaţi centralizat de la o pompă de ulei; aranjarea echidistantă a cilindrilor asigură o repartiţie uniformă a presiunii pe toată lungimea traversei;
- instalaţia de măsurare, monitorizare şi comandă;
- plăcile de egalizare a temperaturii.

Traversele sunt executate din aliaj de aluminiu cu caracteristici mecanice superioare şi au un profil special. Piesele confecţionate din aliaje de aluminiu, pentru instalaţiile de vulcanizat, trebuie să corespundă rolului lor funcţional, în ansamblul din care fac parte, în special să aibă o rezistenţă ridicată la coroziune şi la uzare. Aliajele de aluminiu pot avea diferite compoziţii chimice şi structuri, precum şi diferite direcţii de curgere a materialului metalic în procesul de deformare plastică; proprietăţile speciale ale aluminiului şi ale aliajelor sale (greutate specifică scăzută, plasticitate ridicată, conductibilitate electrică şi conductivitatea termică ridicată, rezistenţă la coroziune); ca urmare aliajele de aluminiu se folosesc, cel mai adesea, la execuţia traverselor din componenţa instalaţiilor de îmbinare prin vulcanizare a benzilor.

Figura 5. *Instalaţie de vulcanizat tip IVB [6]*

Aliajul de aluminiu 3L59, utilizat pentru traversele instalatiei de vulcanizat [7] are caracteristicile mecanice stabilite (tabelul 2) în conformitate cu standardul britanic L100 (BS.EN 3L59).

Tabelul 2. *Caracteristicile mecanice ale aliajului de aluminiu 3L59*

Grosimea nominală [mm]	Rezistenţa minimă la tracţiune [N/mm^2]	Rezistenţa maximă la tracţiune [N/mm^2]	Alungirea minimă pe o lungime de 50 mm [%]
Peste 1,3	160	195	4

Pe parcursul procesului de îmbinare a benzilor, traversele instalaţiei de vulcanizare sunt supuse solicitarilor mecanice, în special cele de încovoiere. La rândul lor, solicitările, provoacă deformaţii ale traverselor care, în final, influenţează calitatea îmbinărilor vulcanizate; se constată că, după o perioadă de funcţionare, apar deformaţii mari şi chiar ruperi ale capetelor libere ale traverselor (fig. 6).

Apariţia deformaţiilor de încovoiere (săgeată) determină erori de tip “clopot”, adică banda va avea o grosime mai mare la mijloc faţă de cea a zonelor de margine. Efectul de tip clopot provoacă scăderea duratei de viaţă a benzii datorită variaţiilor de secţiune ale acesteia.

Figura 6. *Deformaţii şi ruperi ale traverselor instalaţiei de vulcanizare*

In consecinţă, pentru a se evita aspectele negative precizate anterior, s-a adoptat soluţia dispunerii pe capetele libere ale traverselor a unor placi de rigidizare (fig. 7). Creşterea rigidităţii şi scăderea deformaţiilor elementelor instalaţiei de vulcanizare se poate face şi prin suplimentarea numarului de distanţieri, existenţi între traverse, de la patru la şapte. Aplicarea soluţiilor amintite a permis diminuarea efectului de tip “clopot” şi creşterea calităţii vulcanizărilor la E.C. Roşia. Benzile supuse vulcanizării au fost tip SG, cu lăţimi de 1600, 1800, 2000, respectiv 2500 mm şi tip STM cu lăţimi de 1800, 2000, 2250 mm, astfel că pentru un număr de 98 de vulcanizări, executate în decursul unui an, s-au realizat economii de materiale şi de manoperă în valoare de 47.779,88 lei.

Figura 7. *Rigidizarea traverselor instalaţiei de vulcanizare*

CONCLUZII

În procesul de vulcanizare al benzilor din cauciuc este necesară reglarea şi urmărirea concomitentă a trei parametri tehnologici: timpul, temperatura şi presiunea de apăsare a capetelor benzii.

Corelarea temperaturilor şi timpilor de vulcanizare (în instalaţiile cu traverse din aliaje de aluminiu), în special în domeniul cuprins între 65 şi 70 minute, trebuie realizată şi monitorizată pentru a se obţine îmbinări de calitate, a căror rezistenţă şi structură să fie cât mai apropiate de cele nominale ale benzii.

Procesul de vulcanizare al benzilor transportoarelor aflate în dotarea exploatărilor la zi, poate fi îmbunătăţit şi prin micşorarea deformaţiilor elementelor de rezistenţă ale instalaţiilor de vulcanizare, în principal ale traverselor. Soluţiile de rigidizare ale traverselor, redate în lucrare se pot realiza cu uşurinţă şi cu costuri minime, în acest fel, se pot obţine mai puţine întreruperi în funcţionare ale transportoarelor cu bandă precum şi importante economii la costurile activităţilor de mentenanaţă.

BIBLIOGRAFIE

[1]. **Marian, I**., *Utilaje de încărcare şi transport minier*, Editura didactică şi pedagogică, Bucureşti, 1984;

[2]. **Mathias, J., Stark, W**., *Monitoring the vulcanization of rubber with ultrasound:influence of thickness and temperature*, Polymer Testing, vol. 28, pp. 901-906;

[3]. **Gavrilă, L**., *Fenomene de transfer. Transfer de căldură şi de masă*, Vol. II, Editura Alma Mater, Universitatea din Bacău, 2000;

[4]. **Sacadura, J.F.,** *Initiation aux Transfer thermiques Technique et Documentation*, Paris, 1993;

[5]. **Duinea, Adelaida Mihaela,** Transfer de căldură şi de masă, Suport de curs;

[6]. xxx, Cartea tehnică a instalaţiei tip IVB;

[7]. **Armăşoiu, P., Dobrotă, D., Petrescu V**., *Analysis of metallographic structure and hardness of aluminum alloy 3L59 from the structure of vulcanization equipment*, Metalurgija Zagreb, 2015, pp. 547-551.

ANALYSIS OF THE AERODYNAMIC PERFORMANCE OF A POWERED SAILPLANE FROM CS 22 CATEGORIES

S.M. Zaharia

Transilvania University of Brasov, Brasov, Romania, zaharia_sebastian@unitbv.ro

REZUMAT

Aparatele de zbor reprezintă un sistem mecanic complex, cu un număr mare de grade de libertate, cu solicitări complexe, cu forțe și momente aerodinamice diverse. Prin dezvoltarea tehniilor de simulare a zborului și a curenților de aer, acestea permit determinarea caracteristicilor aerodinamice ale unui aparat de zbor într-un timp cat mai scurt. În cadrul acestei lucrari s-au determinat perormanțele aerodinamice (portanța, rezistența la înaintare, coeficientul de presiiune) ale unui motoplanor din categoria de regulamentul CS-22 pentru diverse regimuri de zbor. Curba de variatiei coeficientilor aerodinamici in functie de unghiul de incidenta a fost determinată pentru profilul aripii, pentru aripă și pentru întregul motoplanor. Analiza aerodinamică preliminară a unui motoplanor utilizând programe de analiză specifice se realizează într-un timp cât mai scurt, cu costuri materiale minime determinându-se rapid, caracteristicile principale de zbor.

ABSTRACT

The aircraft is a complex mechanical system with a large number of degrees of freedom, with complex applications with different aerodynamic forces and moments. By developing techniques for flight simulation and airflows, they allow determination of the aerodynamic characteristics of an aircraft in a short time. In this paper it was determined aerodynamic performance (lift, drag, coefficient of pressure) of a powered sailplane category CS-22 rules for different flight regimes. The variation curve of drag coefficient depending on the angle of incidence was determined for the wing profile, for complete wing and full powered sailplane. Preliminary analysis of a powered sailplane aerodynamics analysis using specific programs is achieved in a short time, with minimal material costs quickly determining the main characteristics of flight.

KEYWORDS: powered sailplanes, airfoil, wing, aerodynamic coefficients, pressure

CUVINTE CHEIE: motoplanor, profil aerodinamic, aripă, coeficienți aerodinamici, presiune

1. INTRODUCTION

The powered sailplane is an aircraft whose lifting is done by aerodynamic reactions on surfaces that remain fixed during the same flight regime and is provided with an auxiliary engine, which allows it to fly by own means. Most powered sailplane are equipped with a propeller, which may be fixed, feathering or retractable The engine of powered sailplane cannot always be relied upon to start in flight, so the pilot must allow for this possibility [1].

In figure 1 are presented the forces acting on a powered sailplane in gliding flight (lift, weight, drag, thrust). The lifting force of powered sailplane is the sum of the forces generated by fluid motion around it, projected on a plane perpendicular to the main direction of flow of the fluid in which it is immersed the powered sailplane.

Contrary to the lifting force, which is created by the wing - the main body of the aircraft lifting, drag is also produced by other components of the aircraft: the fuselage, landing gear, empennage and different equipment from the fuselage [2].

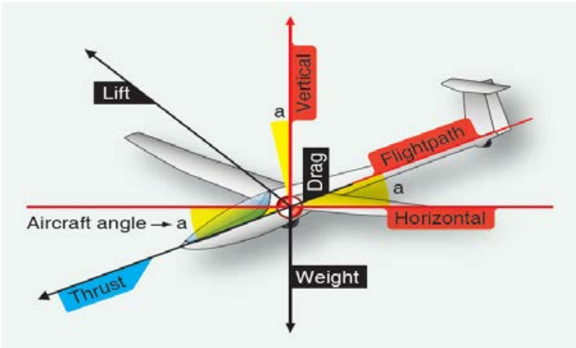


Figure 1: *The four forces acting on a powered sailplane in flight [3]*

To overcome drag force, powered sailplane use a propulsion system to generate a force called thrust. The direction of the thrust force depends on how the engines are attached to the powered sailplane. Weight is a force that is always directed toward the center of the earth. The magnitude of the weight depends on the mass of all the powered sailplane parts, plus the amount of fuel, plus any payload on board.
Certification of a powered sailplane is a set of activities that allow aviation authority to ensure that the product meets both as a whole and for each constituent part technical rules and conditions defined beforehand by authorities.
The main scope of the aviation certification is to ensure that present operational powered sailplane level of security required by aviation regulations. Powered sailplanes built in Europe are following CS-22 rules and designed by EASA - European Aviation Safety Agency. The European Aviation Safety Agency (EASA) is an agency of the European Union (EU) with regulatory and executive tasks in the field of civilian aviation safety.
CS 22 Airworthiness Code is applicable to sailplanes and powered sailplanes categories [4]:
1. sailplanes the maximum weight of which does not exceed 750 kg;
2. single engine (spark or compression-ignition) powered sailplanes the design value W/b2 (weight to span^2) and the maximum weight of which does not exceed 850 kg;
3. sailplanes and powered sailplanes the number of occupants of which does not exceed two.
Touring motor glider means a specific class of powered sailplane having an integrally mounted, non-retractable engine and a non-retractable propeller. It shall be capable of taking off and climbing under its own power according to its flight manual. [4].
In this paper will make an analysis of an airfoil aerodynamic, wing and the complete powered sailplane using XFLR5 software. XFLR5 is analysis software for airfoils, wings and airplanes operating at low Reynolds Numbers.

XFLR5 software includes: XFoil's Direct Airfoil and Inverse analysis capabilities; Wing design and analysis capabilities based on the Lifting Line Theory, on the Vortex Lattice Method, and on a 3D Panel Method [5].
Powered sailplane which will be analyzed in this paper has the following characteristics (table 1).

Table 1: *Powered sailplane characteristics*

Crew	1
Length	7.83 m
Height	1,5 m
Wingspan	20 m
Empty weight	500 kg
Gross weight	750 kg
Powerplant:	1 × Rotax 535C, 33 kW each
Maximum speed	285 /h

2. THE AERODYNAMIC ANALYSIS OF POWERED SAILPLANE'S WING

To create a lifting force that will balance the weight of powered sailplane in flight, the wings are presented in the specially profile section called airfoil [6]. This profile has the advantage of producing large lifting forces, but with a reduced drag. The airfoil for aerodynamic analysis is: Selig/Ashok Gopalarathnam SA7035 (figure 2) with characteristics: maximum thickness 9.2% at 27.9% chord, maximum camber 2.4% at 41.9% chord.

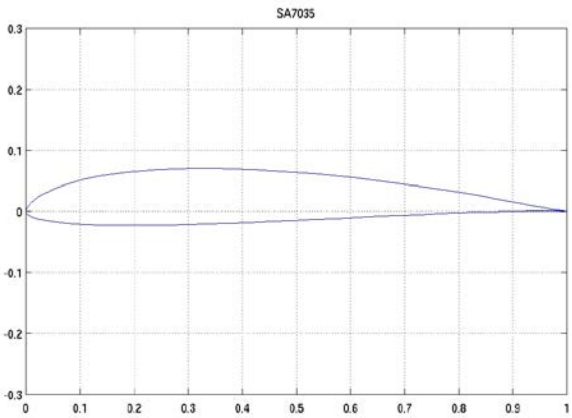


Figure 2: *Airfoil of powered glider – SA 7035 [7]*

Since in the calculation qualities of fly powered sailplane shall know every angle of attack, while the values of coefficients of lift and drag, is widespread method by which the aerodynamic characteristics of profile wing describes a curve called polar aerodynamic profile [8,9,10]. The aerodynamic profile of the wing is primarily dependent on its geometric characteristics (thickness profile, arrow profile, camber). Lift coefficient variation depending on the coefficient drag is described in Figure 3.

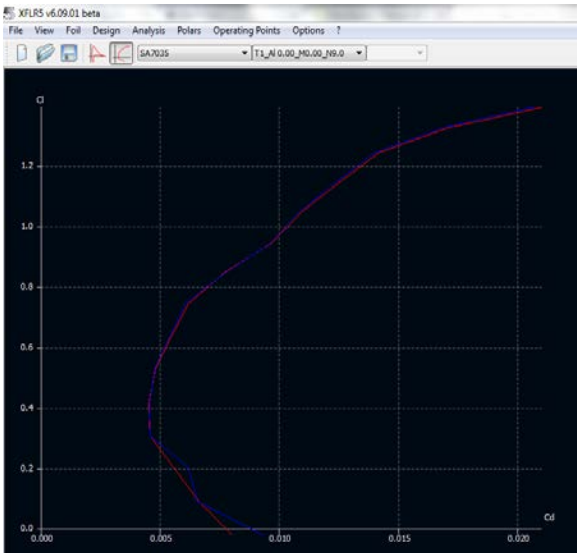


Figure 3: *Polar plot with dependence between the lift coefficients and the drag coefficients*

The drag polar is the relationship between the lift on a powered sailplane and its drag, expressed in terms of the dependence of the lift coefficient on the drag coefficient.

As the drag force is composed of several drag force, so the coefficient Cd can be considered as the result of the sum of the coefficients: coefficient of pressure drag and coefficient of skin friction drag; drag coefficient of the wing and drag coefficient of auxiliary components; coefficient of induced drag and coefficient of noninduced drag [11,12]. Figure 4 shows the dependence between drag coefficients and angles of incidence.

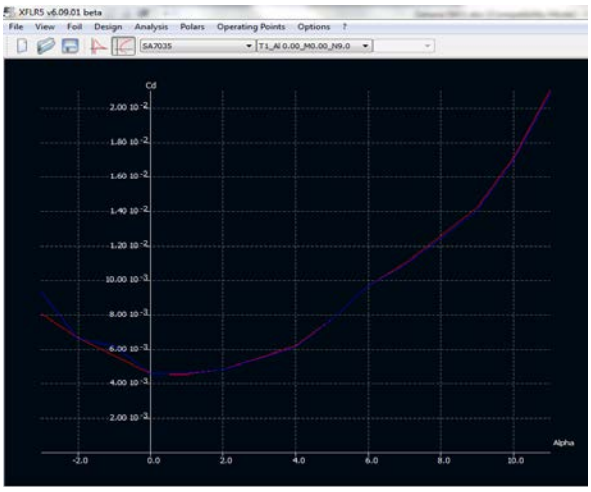


Figure 4: *Dependence between the drag coefficients and the angles of attack*

Next will be performing an analysis of the wing at a speed of 50 m/s and weighing 100 kg and span 20 m. The circulation around the profiles wing is not evenly distributed, but gradually decreases towards the ends of the wing due to marginal losses. Spanwise lift distribution varies depending on the shape of the wing plane, angle of attack, torsion of the wing and flaps existence on trailing edge. Spanwise lift distribution is shown in figure 5, and the distribution of spanwise lift coefficient variation is described in figure 6. There will be a speed at which the two curves will meet. In this area the local lift coefficient intersection (Cl) reached maximum lifting coefficient and therefore, at this point the wing starts flowing separation.

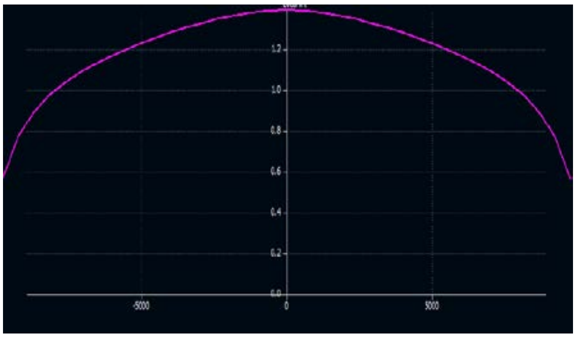


Figure 5: *Spanwise lift distribution of maximum lift coefficients*

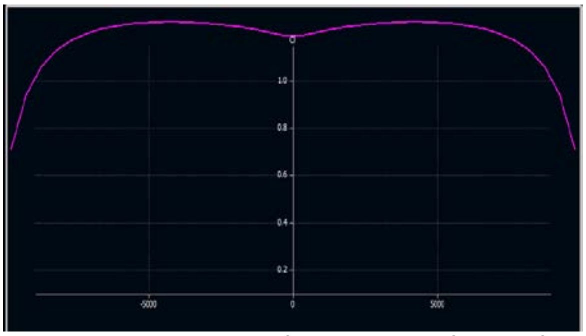


Figure 6: *Spanwise lift distribution of local lift coefficients*

In practice, usually using a "the pressure coefficient" which is defined as the ratio of the pressure difference Δp and the dynamic pressure of the air stream incident. The pressure coefficient is greater on the wing leading edge and is reduced towards trailing edge because the flow accelerates on the wing surface (figure 7).

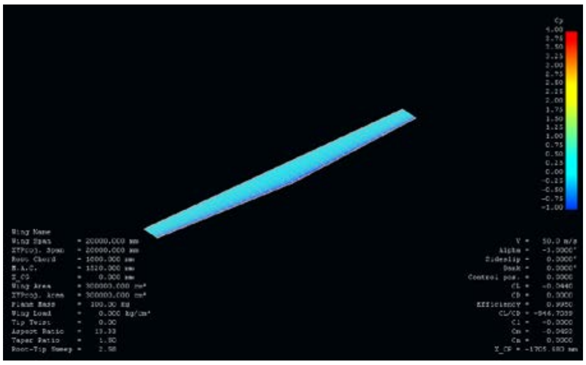


Figure 7: *Pressure coefficient on wing at -3 degrees angle of attack*

In figure 8 it can be seen that wing with a high angle of attack presents a higher pressure coefficient.

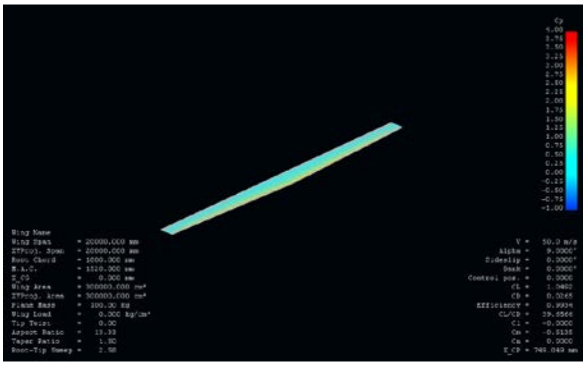


Figure 8: *Pressure coefficient on wing at 9 degrees angle of attack*

The induced drag is the drag force directly associated with the generation of lift force. This results from the dependency of the induced drag on the angle of attack. As the angle of attack of the powered sailplane varies, this type of drag is changed. The induced drag in itself consists of two components. The first part originates from vortices around wing, tail, fuselage, and other components. The second part is because of air compressibility effect. The wing of powered sailplane is the main component contributor for the lift force generation. Thus, about 80% of the induced drag comes from wing; about 10% comes from tail; and the rest create from other components. The induced drag force is a function of airspeed, air density, reference area, and the lift coefficient. From figures 9 and 10 it can be seen that the induced drag increases as the angle of attack of the wing increases.

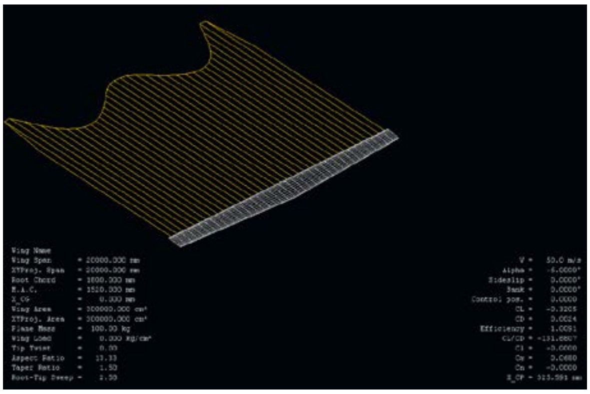


Figure 9: *Induced drag on wing at -6 degrees angle of attack*

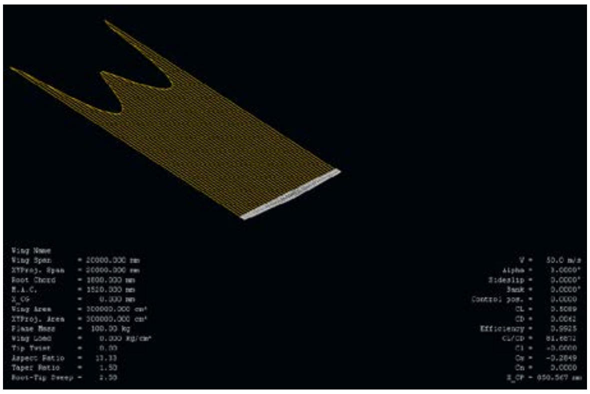


Figure 10: *Induced drag on wing at 3 degrees angle of attack*

The variation of lift coefficient with angle of attack at 50 m/sec for wing of powered sailplane at different angle of attack is shown in figure 11. Then the lift coefficient increases almost linearly with the increase of angle of attack up to approximately 15^0. After wards, the lift coefficient decreases with the further increase of angle of attack. This is a point where the flow separation on the upper surface of the wing is large enough to begin to decrease the overall lift of the aerodynamic surface. As such, the stalling angle of this powered sailplane is found at about 15°. The maximum lift coefficient, CLmax for this type of powered sailplane is approximately 1.45.

Although the lift coefficient and the drag coefficient on wing can be expressed in a number of ways, for reasons of simplicity and clarity, the parabolic polar will be used in all main analyses (figure 12).

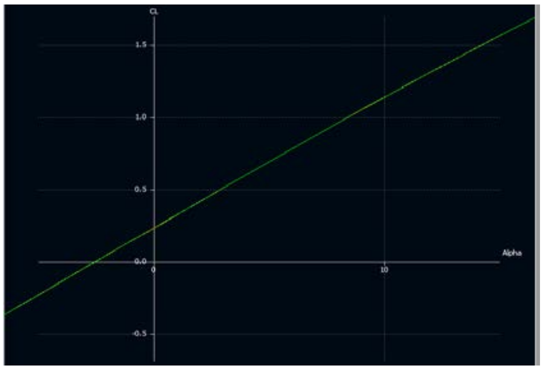


Figure 11: *Aerodynamic coefficients of wing: lift coefficient vs. angle of attack*

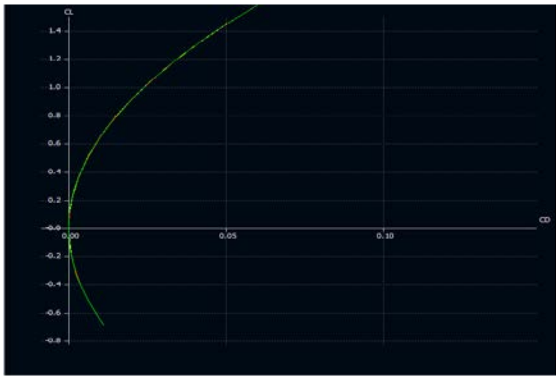


Figure 12: *Aerodynamic coefficients of wing: lift coefficient vs. drag coefficient*

3. AERODYNAMIC ANALYSIS OF THE POWERED SAILPLANE

In aerodynamic flows where the po variation within the flow-field is of particular interest, such as flows with propulsive elements, a convenient non-dimensional form of the total pressure is the total pressure coefficient. Pressure coefficient is very useful to represent pressure in terms of a dimensionless quantity, similar to that of lift and drag. The pressure coefficient on entire powered sailplane is described in figures 13 and 14, for two angles of attack -5 and 10, at a speed of 70 m/s.

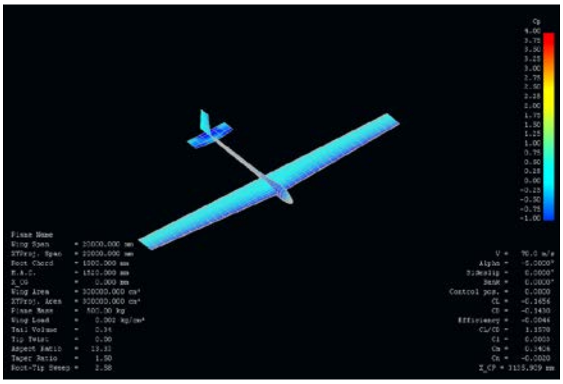


Figure 13: *Pressure coefficient on powered sailplane at -5 degrees angle of attack*

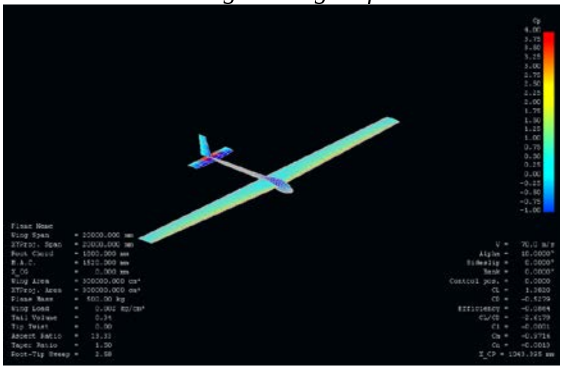


Figure 14: *Pressure coefficient on powered sailplane at 10 degrees angle of attack*

Because the powered sailplanes fly at subsonic speeds, influence of the interference on the aircraft parts' lift is such that the lift force, that occurs on the fuselage and on the other aircraft elements, actually compensates for the lift loss of the wing by the due to fuselage coverage of its central portion. Therefore, from the aerodynamic calculations for subsonic range it can be approximated that the lift of the entire airplane is equal with the wing's lift (figure 15).

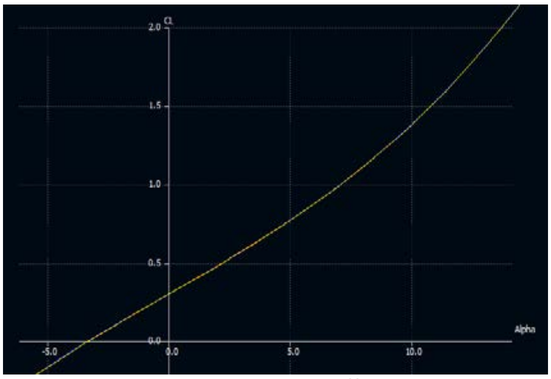


Figure 15: *Aerodynamic coefficients on powered sailplane: lift coefficient vs. angle of attack*

Using a simulation with XFLR5 to see the aerodynamic efficiency of the powered sailplane design, by following the streamlines coming off the powered sailplane surface (figure 16).

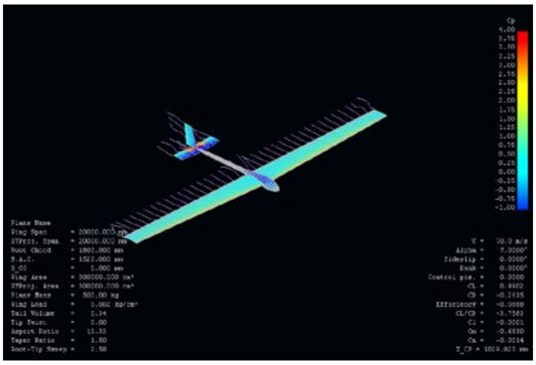


Figure 16: *Streamline around of the powered sailplane*

CONCLUSIONS

When designing a powered sailplane, it is not enough to know only the separate behavior of various elements taken individually, but more than that, aerodynamic characteristics of assembly component elements are of interest. Each of these elements (wing, fuselage, empennage), having sizes and shapes which differ from each other, have different aerodynamic characteristics. After assembling, their component elements keep the aerodynamic characteristics but now they are unified into a single assembly– the complete powered sailplane and they must be homogeneous and well defined.

Simulation of aerodynamic performance is an absolutely necessary activity, as, even since premature phases of a powered sailplane manufacturing, it determines the aerodynamic characteristics (lift, drag, pressure, flow of currents across the entire powered sailplane) and performs some changes in design of the aircraft.

REFERENCES

[1]. **Pajno, V.,** *"Sailplane Design - A Guide for Students and Designers, From Drafting to First Flight"*, College Park Press, Varese, 2010.

[2]. **Katz, J., Plotkin, A.,** "*Low-Speed Aerodynamics*", Cambridge University Press, London, 2001.

[3]. European Aviation Safety Agency [Online]. Available: https://easa.europa.eu/certification-specifications/cs-22-sailplanes-and-powered-sailplanes

[4]. **De Florio, F.,** *"Airworthiness, Second Edition: An Introduction to Aircraft Certification"*, Butterworth-Heinemann Press, Paris, 2011.

[5]. **XFLR aerodynamic software** [Online]. Available: http://www.xflr5.com/xflr5.htm.

[6]. **Gudmundsson, S.,** *"General Aviation Aircraft Design: Applied Methods and Procedures"*, Butterworth-Heinemann Press, New York, 2013.

[7]. **UIUC Airfoil Coordinates Database** [Online]. Available: http://m-selig.ae.illinois.edu/ads/coord_database.html.

[7]. **Boermans, LMM.,** *" Research on sailplane aerodynamics at Delft University of Technology. Recent and present developments"*, Association of Aeronautical Engineers NVvL, 2006.

[8]. **Cucu M. G.,** "*Teoria si tehnica pilotarii planoarelor*", Editura Sport – Turism, Bucuresti, 1981.

[10]. **Bertin, J.J., Cummings R. M.,** "*Aerodynamics for Engineers*", Prentice Hall Press, London, 2013.

[11]. **Flandro, G.A., McMahon H.M., RoachBasic, R.L.,** "*Aerodynamics Incompressible Flow*", Cambridge University Press, London, 2011.

[12]. **Cummings, R.M., Mason, W.H., Morton, S.A., McDaniel, D.R.** "*Applied Computational Aerodynamics: A Modern Engineering Approach*", Cambridge University Press, London, 2015.

RESEARCHES CONCERNING THE ACHIEVEMENT OF AN INTEGRATED DOSING SYSTEM FOR THE BINAR LUBRICANT FLUID

I. Radulescu, A. V. Radulescu

POLITEHNICA University from Bucharest, ROMANIA, e-mail: irena_sandu@yahoo.com

Abstract

The paper presents a study for the achievement of an integrated dosing system for a binary lubricant fluid, followed by an evaluation of its tribological properties and a comparison between this one and the classical pump-driven liquid lubrication solution. An experimental stand was design and realized, in order to test a standard gearbox, alternatively lubricated with both systems. The influence of the two lubrication systems on the performance of the gears and ball bearings was investigated, with variations of load and speed. Statistical techniques were used to design an efficient experimental plan. The dependent variables chosen to be monitored in this experiment were the operating temperature and the level of noise. The extended tests show that the binary lubrication system offers better performance than the classical lubrication system.

1. INTRODUCTION

The present paper presents a study for the evaluation of the tribological properties of the biphasic lubrication system, by comparison with the classical pump-driven liquid lubrication solution.

The liquid-oil circulating systems, while providing advantages, were nevertheless found to impose additional handicaps upon machine design. They can be expensive, machine assembly is more difficult and the pump itself becomes an extra maintenance item. Moreover, the development of extremely high-speed grinders and spindles demonstrated that the liquid-oil environment can cause certain bearings to run hot [1], [2].

Concerning the biphasic lubrication system, it was observed that the distribution of lubricant by conveying oil particles in compressed air overcomes many of the drawbacks of a circulating liquid system.

Using the energy of the compressed air stream allows the generation of a fine, dry, smoke-like fog of oil particles, which can be conveyed over distances up to 150 m and it is possible to be applied directly to the machine element to be lubricated [3], [4], [5].

The most important characteristic of biphasic lubrication which influences the operating temperature, friction and vibration of rolling element bearings is that biphasic lubrication does not require an oil sump in the bearing housing. With biphasic lubrication, the rotating bearing does not churn oil; this results in lower friction, due to the lower energy loss, and lower operating temperature [6].

Also, as the biphasic lubricant at room temperature flows through the narrow passages and over the hot operating surfaces of the bearings, some heat is removed by forced convection from the bearing housing [7], [8].

In the following study, the influence of two lubrication systems on the performance of the test bearings was investigated, with variations of load and speed. The dependent variables chosen to be monitored in this experiment were the operating temperature and the level of noise.

The extended tests show that the biphasic lubrication system offers better performance than the classical lubrication system.

2. EXPERIMENTAL STAND

The experimental stand used for the determination of the tribological performance was a modified FZG stand, with two different lubrication systems: a classical pump-driven liquid lubrication system and a biphasic lubrication system (Figure 1). The main technical parameters of the experimental stand are presented in Table 1.

Statistical techniques were used to design an efficient experimental plan. The experiment was statistically balanced, randomized and blocked. For each experimental run, after applying load and speed, the test gear boxes were allowed to achieve steady state temperature.

At steady state condition, the temperature and the level of noise were measured. The lubricating oil level in the oil sump was maintained at one half the height of the lowest ball in the test bearing at stand still condition as recommended by the bearing manufacturer [2].

The load range was chosen to approximate industrial application conditions. The maximum and minimum test speeds at the pitch diameter were chosen as 5.65 m/s (1000 rpm) and 2.83 m/s (500 rpm) respectively. The maximum speed and load combination was limited by the requirement that a minimum oil viscosity has to be maintained at the operating temperature as recommended by the gear box manufacturer.

Figure 1. *General view of the experimental stand*

Table 1: *Main parameters of the experimental stand*

Technical parameter	Reference value	
Mechanical power	16 kW	
Load	10; 30; 50 daNm	
Speed	500; 750; 1000 rpm	
Temperature	20 ^{0}C	
Time	60 min	
Type of the oil	pump-driven liquid lubrication	TIN 125 EP
	biphasic lubrication	HP38EP
Oil volume	pump-driven liquid lubrication	1.25 l
	biphasic lubrication	0.75 l

Figure 2 presents some constructive details of the temperature measurement system in the bath and from the bearings, and also for the level of noise of the multiplier.

Figure 2. *Details of the measurement systems of the stand*

3. RESULTS

The principle of the test method consists in working a cylindrical gear spur lubricated by a pump-driven system, at constant speed, under certain conditions of temperature and variable load, during a period of time.
The test will be repeated in the same conditions, but with binary lubrication system (air-oil). After that, the results of two tests will be compared, analyzing which one of the two methods of lubrication is more perform ant.
The main results are presented for three different velocities (2.83 m/s, 4.24 m/s, 5.65 m/s), in Tables 2, 3 and 4.

Table 2: *Experimental results for sliding speed 2.83 m/s*

Loading parameter		Parameter	Value of the parameter	
Load [daNm]	Time [min.]		Pump driven lubrication	Biphasic lubrication
10	65	Mean temperature of the bearing, ^{0}C	63	60
		Mean temperature of the bath oil, ^{0}C	58	56
		Noise level, dB	72	70
		Tooth flanks surface	Normal wear	Normal wear
30	58	Mean temperature of the bearing, ^{0}C	69	65
		Mean temperature of the bath oil, ^{0}C	62	59
		Noise level, dB	74	72
		Tooth flanks surface	Normal wear	Normal wear
50	55	Mean temperature of the bearing, ^{0}C	72	68
		Mean temperature of the bath oil, ^{0}C	67	64
		Noise level, dB	77	76
		Tooth flanks surface	Normal wear	Normal wear

For each load, the following parameters will be measured:

- mean temperature of the bearing, with a standard thermocouple;
- mean temperature of the bath oil, with a thermometer;
- noise level from the system, in the gear area, with a transducer type PULSE 3560C;
- Viewing of the tooth flanks surface, using a magnifying glass.

Table 3: *Experimental results for sliding speed 4.24 m/s*

Loading parameter		Parameter	Value of the parameter	
Load [daNm]	Time [min.]		Pump driven lubrication	Biphasic lubrication
10	68	Mean temperature of the bearing, ^0C	69	67
		Mean temperature of the bath oil, ^0C	64	61
		Noise level, dB	75	72
		Tooth flanks surface	Normal wear	Normal wear
30	62	Mean temperature of the bearing, ^0C	74	71
		Mean temperature of the bath oil, ^0C	69	66
		Noise level, dB	79	75
		Tooth flanks surface	Normal wear	Normal wear
50	59	Mean temperature of the bearing, ^0C	76	74
		Mean temperature of the bath oil, ^0C	71	70
		Noise level, dB	80	78
		Tooth flanks surface	Normal wear	Normal wear

Table 4: *Experimental results for sliding speed 5.65 m/s*

Loading parameter		Parameter	Value of the parameter	
Load [daNm]	Time [min.]		Pump driven lubrication	Biphasic lubrication
10	58	Mean temperature of the bearing, ^0C	73	72
		Mean temperature of the bath oil, ^0C	66	65
		Noise level, dB	76	73
		Tooth flanks surface	Normal wear	Normal wear
30	60	Mean temperature of the bearing, ^0C	79	76
		Mean temperature of the bath oil, ^0C	71	68
		Noise level, dB	80	78
		Tooth flanks surface	Normal wear	Normal wear
50	63	Mean temperature of the bearing, ^0C	83	81
		Mean temperature of the bath oil, ^0C	74	71
		Noise level, dB	81	79
		Tooth flanks surface	Normal wear	Normal wear

4. DISCUSSIONS

Analysis of Variance (ANOVA) tests were run on the data using Statistical Analysis Software (SAS). It was found that in these tests the bearings and the shafts had negligible influence on both operating temperature and level of noise. Also as expected, the type of lubrication system, load and speed had strong influences on the operating temperature and noise.

Next, General Linear Model (GLM) procedure, which estimates and tests hypotheses about linear models, was used to model operating temperature and level of noise as functions of the independent variables which have strong influence on the operating temperature as identified in the ANOVA test.

For the operating temperature, the log-log model gave the highest regression coefficient (0.93). This model is plotted in Figure 3 and Figure 4 to show the variation of the operating temperature in bearing and liquid bath with variation of load and speed.

For level of noise, the linear model gave the best R-square value (0.84). This model is plotted in Figure 5 to show the variation of level of noise with variation of load and speed.

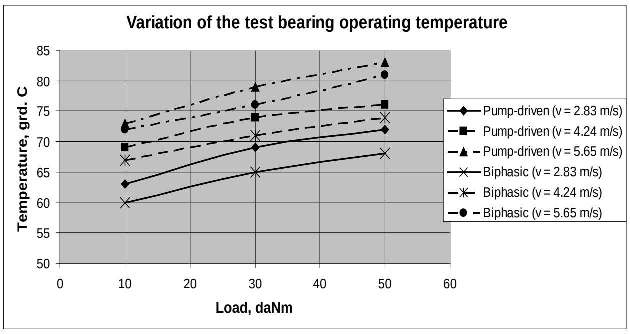


Figure 3. *Graphical representation of the statistical model describing the variation of the test bearing operating temperature with load and speed*

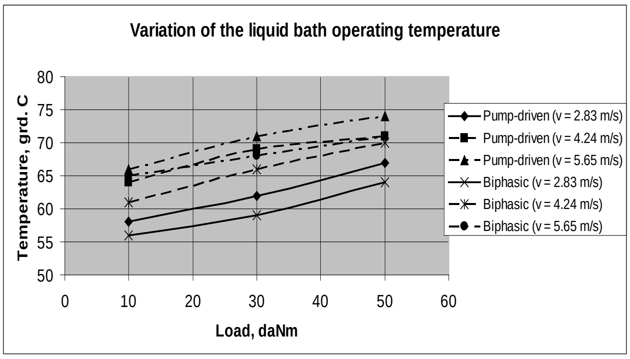


Figure 4. *Graphical representation of the statistical model describing the variation of the liquid bath operating temperature with load and speed*

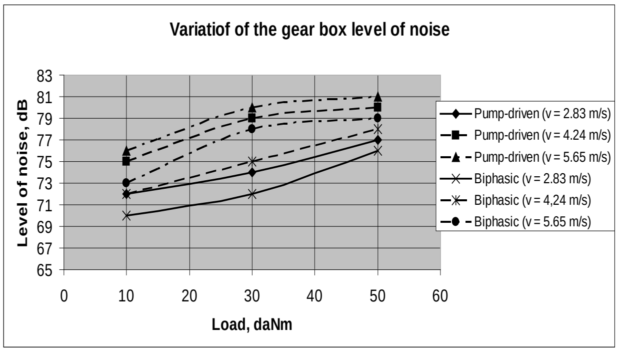


Figure 5. *Graphical representation of the statistical model describing the variation of the gear box level of noise with load and speed*

It can be seen from the plots for the models of temperature and noise that in general the biphasic lubricated bearings operate at lower temperature (5 to 8 ^{0}C) and the level of noise for the corresponding gearboxes decrease with 10-15 % by comparison with pump-driven liquid lubrication system.

It has also been found that the difference in operating temperature and the level of noise between biphasic and pump-driven lubrication systems remain approximately constant with variation of load and speed. Moreover, they do not change appreciably with time.

The reduction of the temperature for the bearings can lead to significant savings in energy when elements of a total petrochemical complex are considered. Also, through better wear and fatigue protection, biphasic lubrication can reduce maintenance requirements and downtime of expensive equipment, leading to saving in resources.

5. CONCLUSIONS

Analysing the previous results, it can be observed that the biphasic lubrication has significant advantages over classical pump-driven liquid lubrication solution:

1. The reduction of the bearing temperature, liquid bath operating temperature and level of noise for the entire gear box;
2. Considering the difference between the temperatures for pump-driven and biphasic lubrication systems, it must be precise that the load and the speed of the bearing have no influence;
3. The low rate of lubricant application, which is made possible with biphasic lubrication, provides continuous lubrication without the requirement of a circulating system design;
4. The continuous application of the oil reduces the manufacturing and installation costs and the oil consumption;
5. The biphasic lubrication is ideally in chemically corrosive environment or in environment where hard particles may invade the bearing cage and cause wear to the load bearing surfaces.

REFERENCES

[1] **Pinkus, O., Decker, O. & Wilcock, D. F**. (1977). *How to save 5% of our energy*, Mechanical Engineering, Vol. 32, pp. 32-33

[2] *** (1985). *Bearing installation and maintenance guide*, SKF Industries Inc., Catalog No. 140-710, Pennsylvania

[3] **Anand, N. K. & McFarland, A.R.** (1989*). Particle deposition in aerosol sampling lines caused by turbulent diffusion and gravitational settling*, American Industrial Hygiene Association Journal, Vol. 50, No. 6, pp. 133-140

[4**] Shamin, A. & Kettleborough, C. F**. (1996). *Aerosol aspects of oil mist lubrication – reclassification and deposition of oil mist in bearings*, Energy Week Conference and Exhibition, Vol. IV, NewYork, pp. 380-385

[5] **Wame, T. M. & Halder, C. A.,** (1984). *Toxicity of lubricating oils*, Journal of the American Society of Lubrication Engineers, Vol. 42, No. 2, pp. 97-103

[6**] Graham, E. E. & Klaus, E. E.** (1986). *Lubrication from the vapor phase at high temperatures*, ASLE Transactions, Vol. 22, No. 2, pp. 229-234

[7] **Erdemir, A.et al**. (1991). *The synergistic effects of solid and liquid lubrication on the tribological behavior of transformation-toughened ZrO_2 ceramics*, STLE-ASME Conference on Tribology, Report No. DE91-018617, St. Louis

[8] **Lauer, J. L. & Dwyer, S. R**. (1990). *Tribochemical lubrication of ceramics by carbonaceous vapors*, Tribology Transactions, Vol. 33, No. 1, pp. 25-32

SISTEME ELECTRONICE DE ACHIZIŢII / DATA ACQUISITION SYSTEMS

Mihai Preda, Alexandru Valentin Rădulescu

POLITEHNICA University of Bucharest, Bucharest, ROMANIA,
e-mail: varrav2000@yahoo.com

REZUMAT
Acest articol abordează oportunitatea tranziţiei unei organizaţii la un sistem electronic de achiziţii, demonstând atât teoretic cât şi practic, cu ajutorul unui studiu de caz, superioritatea unui astfel de sistem atât din punct de vedere al costurilor cât şi al eficienţei, faţă de derularea procesului de achiziţii prin metode tradiţionale. Studiul de caz are menirea de a demonstra simplitatea şi accesibilitatea percepută de către utilizator prin interfaţa de comunicare a sistemului, fără a se face însă rabat de la complexitatea şi rigurozitatea procesului.

ABSTRACT
This article approaches the opportunity of transitioning an organisation to an e-procurement model, by showing both theoretically, as well as practically, using a case study, the superiority of such system from a cost and efficency point of view, to a traditional procurement process. The purpose of the case study is to showcase the simplicity and accessibility perceived by the end user through the user interface, while not making any compromises with regard to the complexity and thoroughness of the back-end process.

CUVINTE CHEIE: achiziţii, software, interfaţa cu utilizatorul

KEYWORDS: procurement, software, user interface

1. INTRODUCERE

Pentru a înţelege conceptul de e-procurement (sistem electronic de achiziţii) este neceesar să discutăm despre e-commerce (comerţul electronic), întrucât aceste concepte sunt strâns legate şi uneori interschimbabile. Aceşti termeni vor fi definiţi în cele ce urmează.

Conceptul de e-business se referă la o definiţie mai largă a comerţului electronic, incluzând nu doar segmentul de cumpărare şi vânzare a bunurilor şi serviciilor, ci şi servirea clienţilor, colaborarea cu partenerii de afaceri şi desfăşurarea tranzacţiilor electronice în cadrul unei organizaţii. [1]

Conceptul de e-procurement este o parte importantă din conceptul de e-business şi acesta din urmă a ajutat în evidenţierea sistemului de achiziţii că fiind un element strategic pentru organizaţie. [1]

Trecerea funcţiei de achiziţii de la un aspect secundar al organizaţiei la un pivot strategic fundamental şi tendinţa de automatizare şi fluidizare a procesului sunt două fenomene care se motivează şi sprijină reciproc, ele nefiind în mod clar una urmare a celeilalte, ci ambele constituie simultan şi cauză şi efect.

British Chartered Institute of Purchasing (CIPS) a definit conceptul de achiziţii ca fiind “ procesul întreprins de către unitatea organizaţională care, fie ca o funcţie sau ca parte integrantă a lanţului de aprovizionare este responsabilă atât pentru procurarea proviziilor de o calitate şi cantitate corectă, timp şi preţ adecvate, cât şi de managementul furnizorilor, contribuind astfel la crearea sau menţinerea avantajului competitiv al organizaţiei şi realizarea strategiei organizaţionale”[2].

2. CLASIFICĂRI ŞI TENDINŢE ACTUALE

2.1. Motivaţia implementării unui sistem de achiziţii electronic este dat de o serie de avantaje cum ar fi reducerile de costuri substanţiale care au un impact direct asupra clientului. [3]

Valorificarea adoptarii sistemelor de achiziţii electronice a fost accelerata de avansarea tehnologiei specifice cât şi de discipline complementare cum ar fi managementul contractelor.

În afară de reducerea birocraţiei şi timpilor de comunicare, sistemul electronic de achiziţii trebuie să fie direcţionat către îmbunătăţirea performanţei celor cinci obiective ale funcţiei de achiziţii şi anume[3]:

- preţul corect
- livrarea la timp
- calitatea adecvată
- cantitatea corectă
- de la o sursă adecvată

Simptomele unor practici inadecvate de achiziţii pot fi identificate şi evidenţiate mult mai uşor cu ajutorul mijloacelor electronice de analiză şi desfăşurare a acestui proces, cum ar fi obiceiuri de achiziţii nedocumentate şi procese de business redundante.

Croom and Johnson (2003) argumenteaza că sistemul electronic de achiziţii nu este doar o adăugare a unor aspecte tehnice la procesul de achiziţii tradiţional, ci oglindeşte acest proces prin furnizarea a două infrastructuri separate, dar interconectate: procesarea internă (intranetul organizaţional) şi procesarea către exterior (platforma bazată pe Internet). [4]

2.2 Modele ale unui sistem electronic de achiziţii

Există trei categorii de aplicaţii de procurement:

- buy-side desktop requisitioning (rechiztitia centrată pe cumpărător)
- buy side centralised procurement management (Gestiunea achiziţiilor centrată pe cumpărător)
- sell-side applications (Aplicaţii centrate pe vânzător)

Software-ul de rechizitii centrate pe cumpărător permite angajatului sa cumpere online în timp ce compania menţine procesul de aprobare şi direcţionare. Conectând intranetul organizaţiei cu site-urile web-based ale furnizorului, software-ul centrat pe cumpărător redirecţionează intern cererile de achiziţie ale angajatului înainte de a se transforma în comenzi..

Gestiunea achiziţiilor centrată pe cumpărător permite managerilor de achiziţii să gestioneze procesele, să analizeze date tranzacţionale şi să efectueze un management eficient al furnizorilor.

2.3 Metode specifice achiziţiilor centrate pe cumpărător

- e-sourcing (prospectare a bazei de furnizori)
- e-tendering
- e-reverse auctioning (licitare inversă)
- web based ERP (planificarea electronică a resurselor)
- e-MRO (mentenanţă, reparaţii şi operare)

Aplicaţiile centrate pe vânzător reprezintă un model care ajută vânzătorii să implementeze şi susţină comerţ electronic şi stocuri virtuale. În acest model, un singur furnizor poate contacta mai mulţi cumpărători şi poate livra direct către consumatorii finali, poate capta şi gestiona comenzi online şi îmbunătăţi relaţia cu clienţii oferind suport eficient din punct de vedere al costului. Aceste aplicaţii adesea includ instrumente de creere şi întreţinere a cataloagelor electronice de produse, cât şi suport tranzacţional pentru efectuarea comenzilor de către clienţi..

3. BENEFICII ALE SISTEMELOR ELECTRONICE DE ACHIZIŢII

3.1 Avantaje ale sistemelor electronice de achiziţii

• Beneficii directe – sunt direct măsurabile şi este necesar că ele să îmbunătăţească direct valoarea activităţii, cum ar fi economisiri la preţuri şi reduceri de cost al procesului.

• Beneficii indirecte – pot fi dificil de cuantificat dar pot fi buni indicatori ai progresului. Exemplele include timp eliberat prin procese mai eficiente

•Beneficii intangibile – nu sunt direct măsurabile în termeni financiari. beneficiile indirecte nu trebuie să fie clasificate ca intangibile doar pentru că sunt mai dificil de măsurat. În schimb, acestea includ:

- ➢ schimbări culturale – implică recunoaşterea prospectării strategice a furnizorilor ca un diferenţiator de piaţă pe termen lung, o schimbare a atitudinii faţă de utilizator şi folosirea proceselor globale.
- ➢ aprobarea financiară pentru toate cheltuielile – capacitatea de a asigura că toate cheltuielile se ridică la standardele organizaţiei
- ➢ vizibilitate mare a performanţei furnizorilor

Aceste beneficii mai sunt clasificate sub 4 mari categorii:[5]

1. Beneficii tranzacţionale

Sistemul electronic de achiziţii permite efectuarea plăţilor online. De obicei, un instrument web-based este folosit, în care produsele sunt selectate dintr-un catalog prestabilit şi trimise pentru aprobarea electronică. Există o legătură şi cu sistemul de planificare a resurselor organizaţionale (ERP) pentru introducerea datelor de identificare, plata facturilor şi comasarea informaţiei necesare pentru management. Din acest proces rezultă economii de timp uriaşe datorită:

- proceselor automate globale care încorporează cele mai bune practici şi elimină activităţile nenecesare
- relaţiilor susţinute electronic cu furnizorii ceea ce grăbeşte ciclul de achiziţii şi facilitează îmbunătăţirea performanţei furnizorilor
- preciziei crescute a datelor ce minimizează neconcordanţele din comenzi şi furnizează fundaţia esenţială pentru management prin măsurători şi analize

2. Beneficii de conformitate.

În multe organizaţii, problemele de conformanţa şi cheltuielile haotice sunt semnificative şi necesită atenţie. Această se întâmplă deoarece angajaţii nu sunt de obicei conştienţi de înţelegerile stabilite şi mai puţin din cauza faptului că ignoră conştient procedurile şi procesele stabilite. Sistemul electronic de achiziţii adresează această problema prin instrumentele sale cum ar fi cataloage şi procese standard de comandă şi aprobare. Conformanţa va fi obţinută datorită:

- unui proces simplu de rechiziţie (solicitare pentru o comandă) şi plata care include o interfaţă prietenoasă cu utilizatorul şi cataloage adaptate nevoilor utilizatorului
- informaţiei uşor accesibile şi proceselor standard de achiziţii implementate
- faptului că sistemul electronic de achiziţii rămâne în timp, singurul disponibil

3. Beneficiile pentru managementul informaţiei

Faptul că informaţiile cheie cum ar fi centrele de cost sunt încorporate în program reduce dramatic erorile şi furnizează date foarte detaliate şi uşor accesibile.

Acest lucru este foarte important în maximizarea potenţialelor beneficii ale politicii strategice de achiziţii. O implementare de succes a unui sistem electronic de achiziţii va furniza managementului date de înaltă calitate şi va anula nevoia de stocare a informaţiei

4. Beneficii cu privire la preţ

Capacitatea de a dovedi furnizorilor că organizaţia foloseşte un sistem electronic de achiziţii care asigură onorarea statusului comenzilor de către utilizator va îmbunătăţi capacitatea de negociere prin:

- surprindere mai eficientă şi deci mai de încredere a informaţiilor despre cheltuieli
- încredere crescută că volumele de cheltuieli pot fi garantate prin conformanţa crescută cu sistemul,permiţând astfel reduceri de preţ datorate volumului ridicat.

Operarea cu succes a primelor patru beneficii permite plata electronică a facturilor. Această include abilitatea de a controla mai bine fluxul monetar şi de a gestiona eficient plăţile către furnizori datorită unui proces mai fluent de achiziţii, care furnizează informaţii mai precise şi actuale departamentului contabil.

Potenţiale beneficii includ nevoia redusă de personal şi cheltuieli poştale reduse. Când vine vorba despre negocieri, implementarea unui sistem electronic de achiziţii poate garanta furnizorului o plata promptă. De obicei, beneficiile facturării electronice sunt ignorate sau subestimate.

Multe firme vor proteja deci datele despre activitatea sa şi variabilele competitive pentru a contracara eventualele acţiuni oportuniste ale unei organizaţii partenere.

3.2. Potentiale riscuri implicate de implementarea unui sistem electronic de achizitii.

În ciuda numeroaselor beneficii ale sistemelor electronice de achiziţii, că în cazul oricărei îmbunătăţiri a unui model de afaceri, există şi potenţiale riscuri sau dezavantaje în cadrul unui sistem netestat, astfel încât multe firme tranzitorii for respinge implementarea să din cauza conştientizării acestora.

Dezavantajele aferente implementării unui sistem electronic de achiziţii includ riscuri de securitate, integrare limitată a furnizorilor, baza de cost a tehnologiei crescută, nevoia de resurse educaţionale ridicate.

Probabil că cea mai influentă dintre toate variabilele este paleta largă de nevoi educaţionale , training şi expertiză tehnologică . În mod similar, alocarea directă de resurse pentru implementarea sistemului poate submina beneficiile pe termen lung ale proceselor electronice de achiziţii.

De asemenea, natura sistemelor de achiziţii necesită o integrare mutuală a sistemelor partenerilor de afaceri. Acest lucru poate presupune accesarea datelor confidenţiale cum ar fi vânzările şi statutul stocurilor, iar acest lucru poate afecta obiectivele pe termen lung ale afacerii.

4. STUDIU DEMONSTRATIV

4.1. Descrierea soluţiei utilizate

În prezentul studiu de caz vom demonstra un exemplu de utilizare a soluţiei de procurement de la compania Ariba în cadrul companiei Dell International Services SRL.

Ariba este o companie de servicii IT localizată în Sunnyvale, California. Compania a fost achiziţionată în 2012 de către producătorul german de software, SAP.[6]

Ariba a fost fondată în 1996 pe ideea folosirii internetului pentru a facilita şi îmbunătăţi procesele de achiziţii. Achiziţiile erau în acel moment bazate pe hârtie, presupuneau muncă intensivă şi procese ineficiente pentru marile corporaţii. Potrivit site-ului oficial, Ariba frunizeaza “soluţii de management al cheltuielilor” care ajută companiile să ‘’analizeze, înţeleagă şi să gestioneze cheltuielile organizaţionale pentru a realiza economii şi eficientiza procesele de business’’. [6]

Compania este cunoscută pentru modalitatea “Software as a Service’’ în care îşi livrează soluţiile. Această presupune licenţierea software-ului pe baza de subscripţie sau abonament şi este găzduit central, fiind cunoscut şi ca software la cerere.

Dell International Services este divizia de servicii şi suport a Dell Inc, gigantul american de hardware.

În cele ce urmează este prezentat fluxul prin care trece o rechiziţie în cadrul companiei, folosind soluţia de procurement de la Ariba.

4.2. Fluxul procesului de comanda

In continuare este prezentat fluxul logic al efectuarii unei rechizitii de catre un utilizator intern, prin evidentierea interactiunii dintre sistemele informatice proprie organizatiei si cele ale furnizorului de servicii de software, in scopul de a crea un proces unitar si simplificat.

Deşi imperceptibil pentru utilizator, sarcina procesării comenzii trece de la furnizorul de servicii software la sistemul intern pentru aprobare şi verificare, urmând să fie retrimisă la serverele Ariba, urmând că în final să ajungă la furnizorul apelat prin efectuarea rechiziţiei. Tot acest proces este complet transparent pentru utilizator, astfel evitându-se o serie de componente birocratice ale procesului, dar păstrându-se respectarea principiilor de integritate a informaţiei şi non-repudierii acţiunilor.

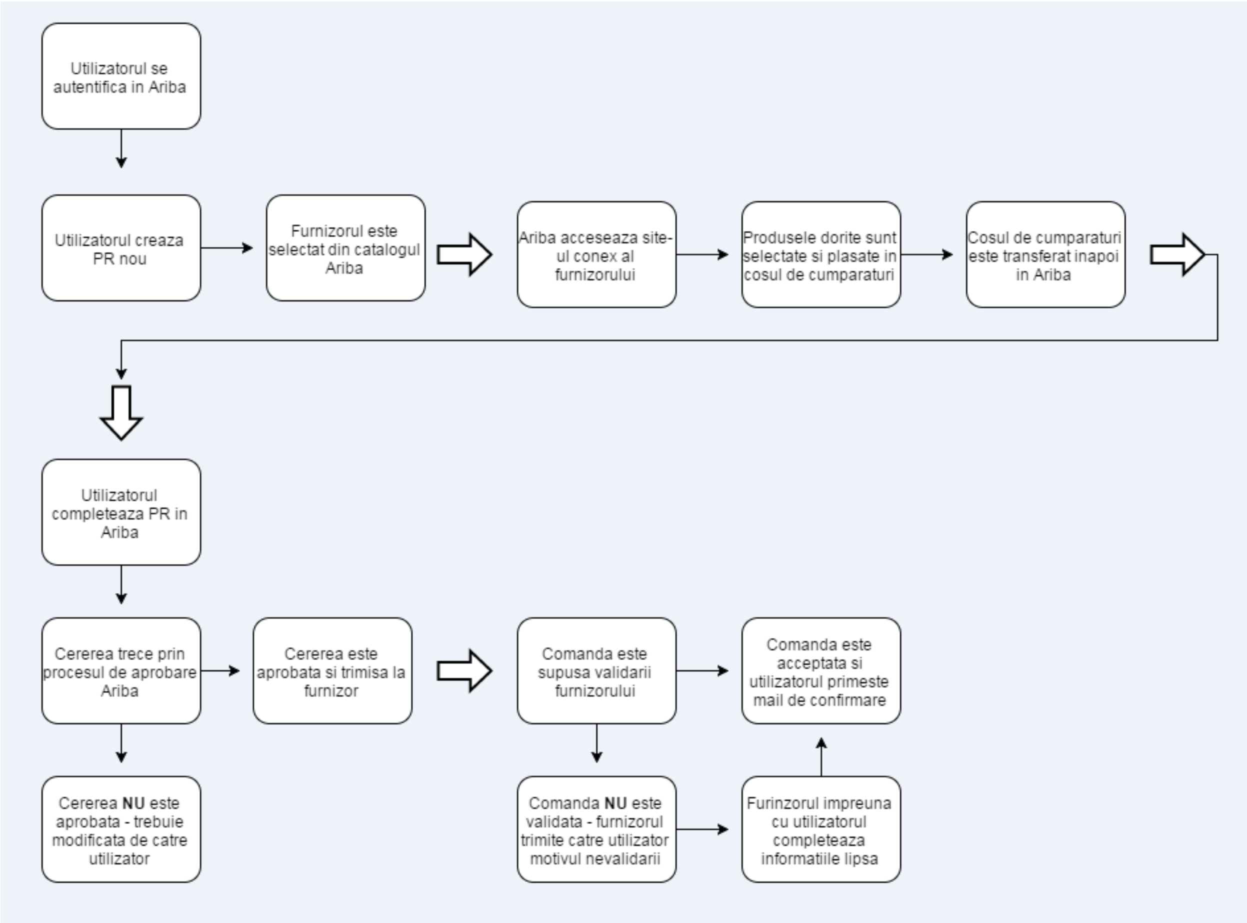


Fig. 4.1. *Fluxul logic al procesului de comandă*

4.3 Exemplu practic de rechizitie

De asemenea, pentru a înţelege diferenţa dintre procesul tradiţional de achiziţii şi utilizarea unui sistem electronic de achiziţii, vom demonstra practic experienţa unui utilizator, prin exemplificarea pasilor urmariti de acesta si capturile ecranelor intampinate. [7]

Modelul de sistem electronic de achiziţii este, aşa cum am amintit la capitolul 2, buy-side desktop requisitioning.

1. Utilizatorul se autentifică în Ariba, utilizând credentialele individuale. În funcţie de nivelul de acces, va întâmpina unul dintre cele două ecrane de mai jos (Fig 4.2. sau Fig.4.3.).

2. Crearea rechiziţiei - acesta se realizează printr-o interfaţă prietenoasă cu utilizatorul, în mod similar plasării unei comenzi virtuale în afara mediilor organizaţionale..

3. Completarea detaliilor necesare

- Descriere sumară dar relevantă
- Selectare “No” pentru POAF
- Cererea chitanţei într-un numar finit de zile
- Selectarea tipului de rechiziţie
- Selectarea locaţiei.

Toate informaţiile despre livrare vor fi completate automat de către Ariba, pe baza conexiunii acestuia cu reţeaua intranet proprie organizaţiei, utilizatorul fiind nevoit doar să verifice corectitudinea acestora.

De asemenea, utilizatorul are obligaţia de a completa câmpul “Need by date”, referitor la data oportună livrării subiectului rechiziţiei, această informaţie neputând fi dedusă sau extrasă automat de către sistem.

4. Tastarea numelui furnizorului în căsuţa de căutare şi iniţializarea cautarii

Utilizatorul poate alege furnizorul preferat, sau furnizorul poate fi stabilit prin politici organizatioonale pentru anumite cfategorii de cheltuieli. În unele cazuri, utilizatorul încă are un grad de libertate în alegerea acestuia, dar numai din opţiunile înregistrate oficial în sistem.

5. Se afişează o listă de produse disponibile şi accesoriile aferente

Se pot afişa toate produsele furnizorului selectat sau doar anumite produse, selectate printr-o căutare prin cuvinte cheie. Produsele la care există un discount sau pentru care există o pre-înţelegere între companie şi furnizor, pot avea un indicator de semnalizare. De asemenea, aplicaţia poate rula rapoarte comparative între preţurile şi disponibilităţile produselor similare ale aceluiaşi furnizor sau chiar între produse ale unor furnizori diferiţi, datorită caracterului unitar al stocării informaţiei.

6. Odata adaugate toate produsele dorite in cosul de cumparaturi, se va selecta "Checkout" si rechizitia va fi trimisa pentru aprobare.

7. De îndată ce rechiziţia este revizuită şi aprobată, comandă este generată şi trimisă electronic în mod automat de către Ariba spre furnizor.

8. Când comanda ajunge la furnizor, acesta va confirma primirea comenzii prin mail şi va trimite celelalte detalii legate de comandă, marcând finalul procesului de rechiziţie, celelalte etape până la primirea produselor fiind parte din alte activităţi.

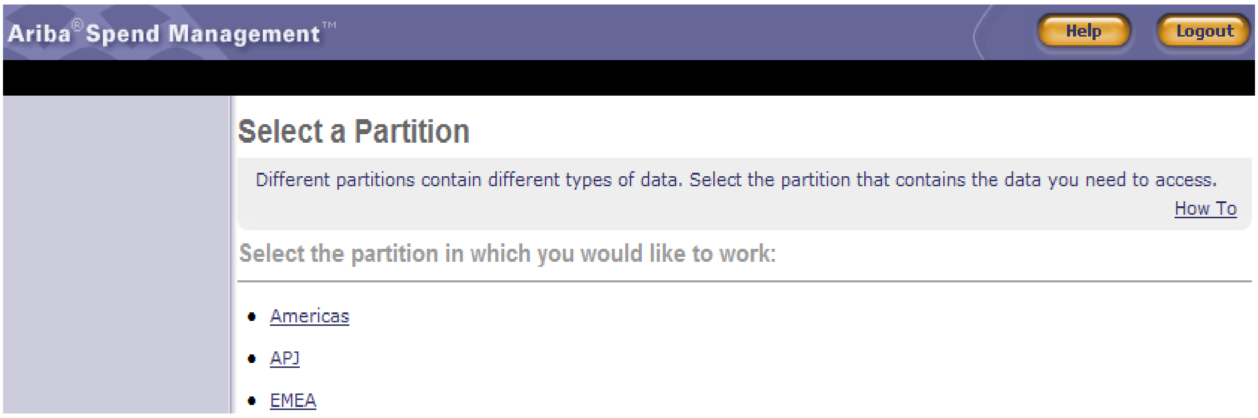


Fig 4.2. *Ecranul A: Pagina iniţială pentru utilizatori cu acces special*

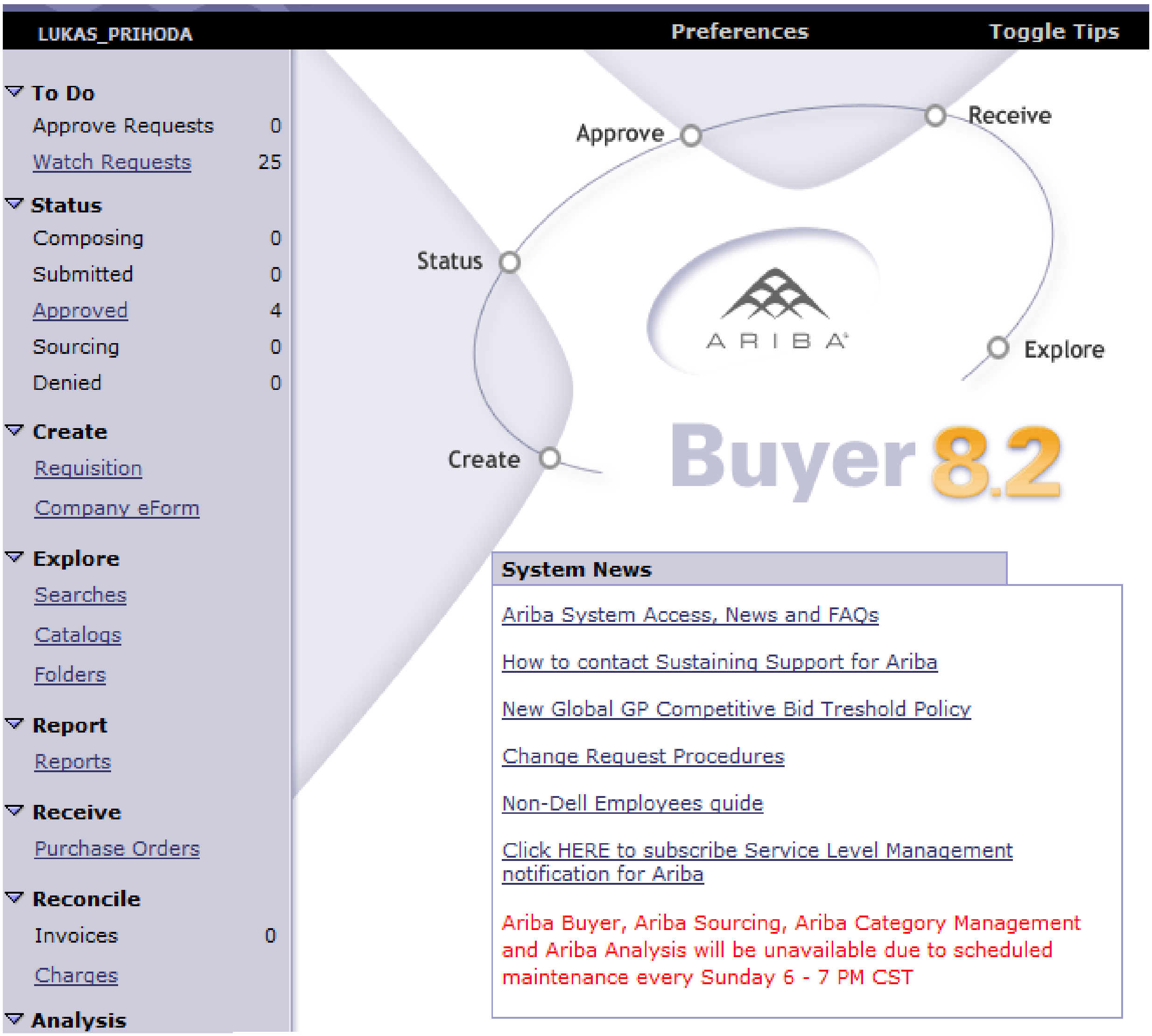


Fig 4.3. *Ecranul B: Pagina iniţială pentru majoritatea utilizatorilor*

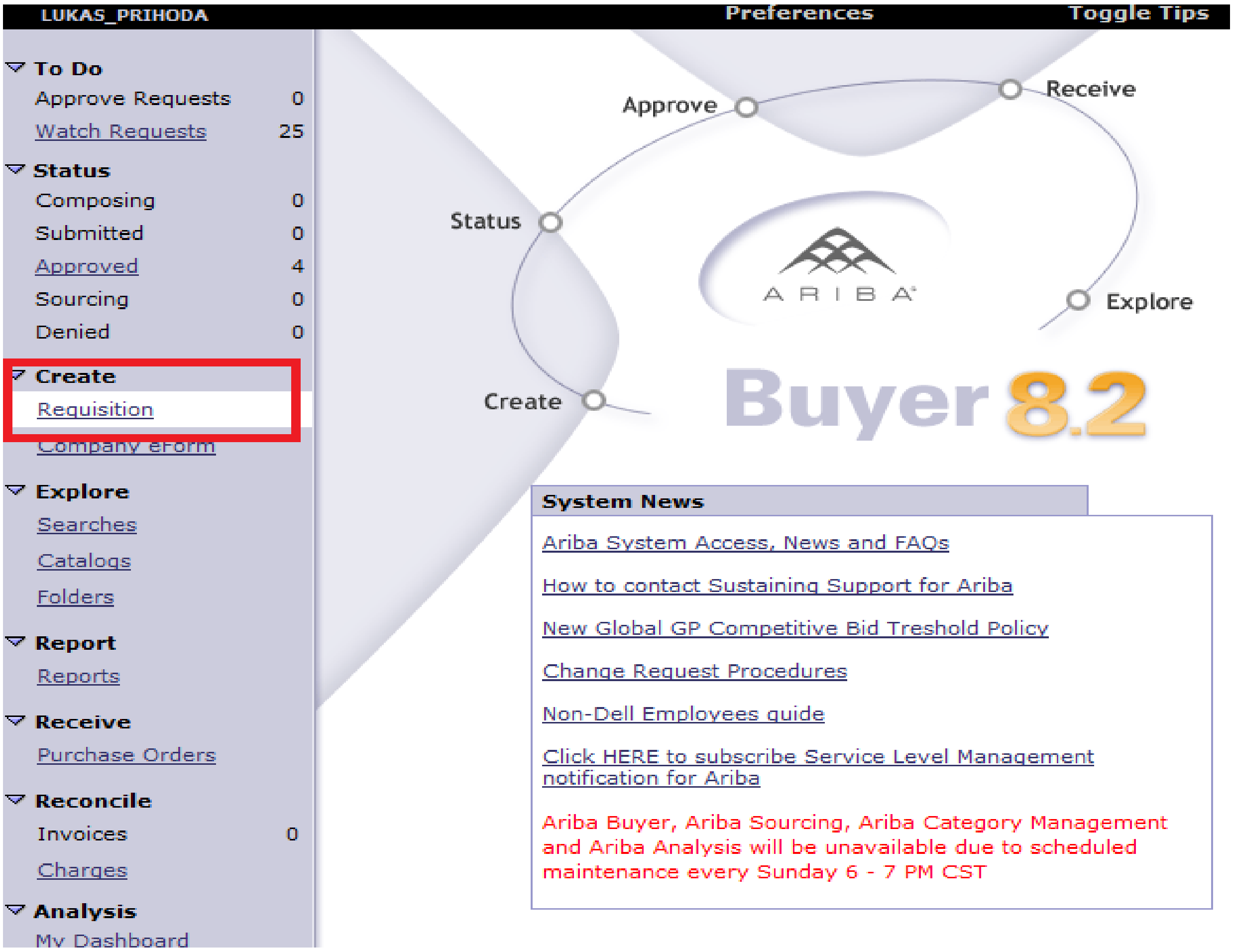


Fig 4.4. *Crearea unei rechiziţii în Ariba*

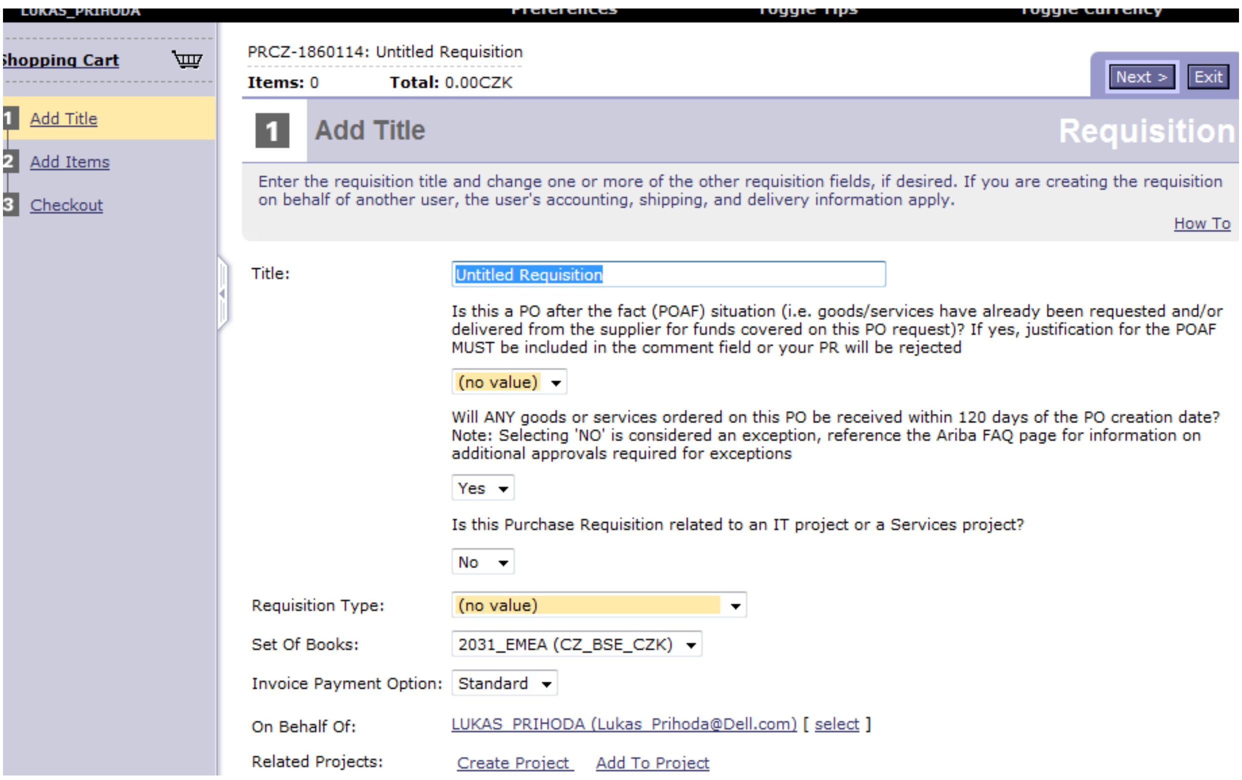


Fig 4.5. Completarea detaliilor cerute de aplicatie

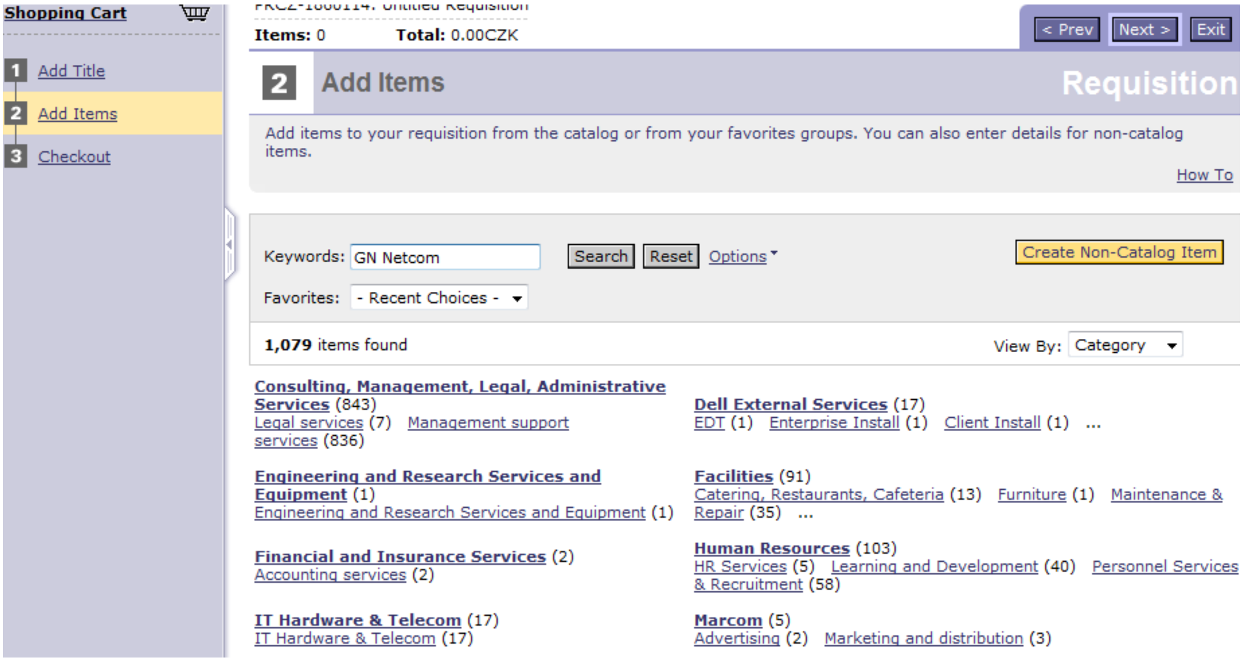


Fig 4.6. Căutarea furnizorului în baza de date

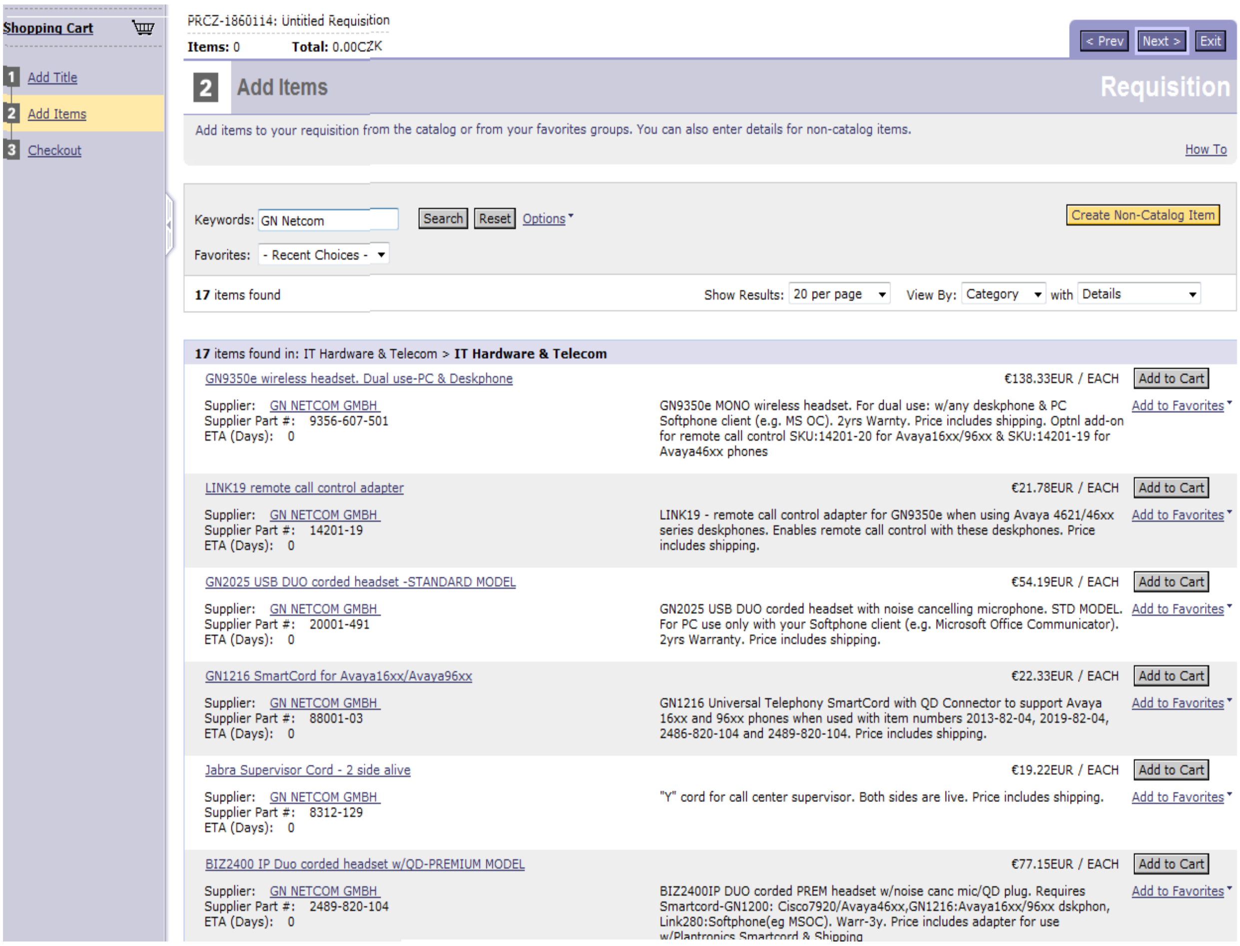


Fig 4.7. Listarea produselor disponibile

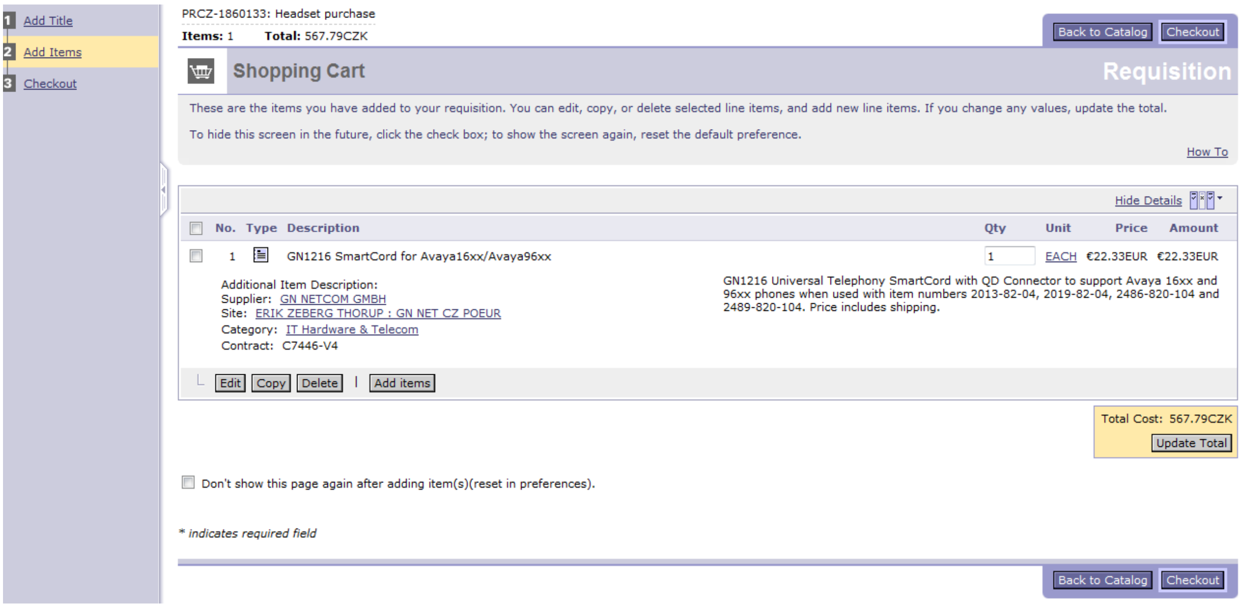


Fig 4.8. *Finalizarea rechizitiei*

5. CONCLUZII

Implementarea unui sistem electronic de achiziţii are rolul de a transforma un proces greoi şi intens birocratic, într-o simplă interacţiune între utilizator şi interfata aplicatiei, majoritatea etapelor procesului fiind fie automatizate, fie invizibile pentru cumpărător. Această opţiune devine un imperativ pentru organizaţiile medii şi mari, deoarece ignorând acest aspect al eficientizării activităţii organizaţiei, se poate diminua sau chiar pierde avantajul competitiv.

Se conturează astfel o piaţă emergentă a software-urilor specifice sectorului achiziţiilor, fie independent, fie ca parte integrantă a unui pachet e-business, fiind de cele mai multe ori livrat ca un serviciu, incluzând mentenanţă, update şi suport pe perioada subscriptiei, software-ul contractat nefiind instalat fizic pe serverele companiei ci doar apelat de pe serverele furnizorului de servicii software, atunci când este necesar. Acest lucru permite o mai bună utilizare a resurselor, eliminarea redundanţelor şi cheltuielilor de infrastructură şi drepturi intelectuale, dar presupune încheierea unui Acord de Nivel al Serviciilor (Service Level Agreement) între părţi, pentru a asigura disponibilitatea serviciului în orice condiţii (vârfuri de activitate, catastrofe naturale, etc.).

În alegerea unei soluţii ce conţine un sistem electronic de achiziţii, organizaţia contractantă trebuie să ţină cont de o serie de caracteristici individuale cum ar fi dimensiunile firmei, cifra de afaceri, perspectivele de viitor, ponderea achiziţiilor în cheltuielile totale, perspectivele pe termen lung, pentru a asigura oportunitatea alegerii implementării sistemului.

Odată cu perfecţionarea tehnologiei specifice şi creionarea unor proceduri şi recomandări generale de bună practică în implementarea unui sistem electronic de achiztii, costurile materiale şi logistice ale acestuia se diminuează, făcând adoptarea acestuia de către majoritatea organizaţiilor, aproape o certitudine pentru viitor.

BIBLIOGRAFIE

[1] **Turban, E., Lee, J., King, D., Chung, H.,** (2000) *Electronic Commerce, A Managerial Perspective,* Prentice Hall, New Jersey

[2] **Kenneth Lysons, Michael Gillingham, Mike Gillingham,.** *Purchasing and Supply Chain Management*, 2003

[3]. **Peter Baily,** *Procurement, Principles and Management,* , 2003

[4] **S. Croom, R. Johnson**, E-service: enhancing internal customer service through e-procurement
International Journal of Service Industry Management, Vol. 14 (No. 5) (2003)

[5] **David Eakin,** *Measuring e-procurement benefits* www.summitconnects.com, Summit Magazine, feb. 2003

[6]. **www.ariba.com**

[7] Procedura Dell – non-restricted