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Tool Automatic Selection: A proposition

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Abstract. *The unproductive time in the tools change, the necessary times for the tools choice tool in function of the material and geometry of the workpiece are some of the main concerns of the companies with the cost/benefít and productivity. The surface quality allied to the criterion of maximum production can be adverse in its ways, because to select a tool in which a larger production is aimed at by workpiece without reducing the superficial quality, it will always be objective of any company. Some support softwares to the productivity, besides it be specific and its modulate, as for instance, of administration of tools, optimization and planning of processes, its have possess high costs for small companies. Also reminding that, some of those systems as the one of process plannings doesn't take into account the selection of tools, because it can still become more complex the in detail of that planning. Then, thinking about those conditions this system was proposed. The work constitutes a proposal of a development of a system for automatic selection of cutting tool in machining operations. The program it is being developed in Delphi® 6.0 (in windows environment). The objective of development was looking for a decrease of the time production, being taken into account the material of the workpiece, the cutting tool, the geometry holder, the available machines and the cutting conditions for a given geometry. All the necessary information are filed and moved inside of a linked database to the system. Will be presented in this article some screens of the system and that will lead in the end to an answer showing a cutting tool selected for a turning operation.*

Keywords. machining,data base, tool selection

1. Introduction

The choice of the appropriate tool for a certain operation and the correct determination of the machining conditions, it represent an important paper in the work with metals, being a decisive factor of the evolution of the machine-tool and the cutting tools. Such fact increases in the seriate production, where divergences in the choice of the cutting speed and tool can cart notable variations in the production costs Ferraresi (1989). In the specific case of the metal-mechanics industry, where the operations of cylindrical turning are very used, to optimize the conditions of production of these operations means to reduce the production times of workpieces and the assembly times of the systems as a completely.

In this aspect, it fits to point out that will always have a concern with the times reduction of wait and the preparation times of the machine-tool, increasing like the participation of the times in which the workpiece stays inside of the machine (times of tool change, passive times and times cutting) in the total time of production.

It is observed like this developments in systems aided by computer for the automation of the planning. The efficiency and the automation degree of the machining processes depend significantly on the existence of cutting data detailed, updated and of easy access. The automatic tool selection and a process planning depends on that context, of efficient databases.

According to Eversheim et al. (1991), the process of industrial production have a narrow relationship between project and production, with regard to aspects organizacionais and of data. Researches are driven typically to the arbitrary decomposition of defined subproblemas on different domains of geometry of the workpiece and of process, taking thoroughly to results several, typically incompatible with the concept of integrated system. The generation of plans of processes depends on the material, geometry of the certain workpiece for the customer, determination of the sequence of the process activities, selection of the machine-tool, tools, fixation devices and, calculation of the time.

In this present work, the proposal of an automatic system of tool selection will be presented for machining, with databases aided. The program in development is being implemented in Delphi® 6.0 and in window environment. To visualize the proposal work better some functional screens of the system its will give a view of the system. The objective would be of selecting a better tool in function of the variables of the machining process.

2. Tool Selection

The machining of metals is a complex processes, composed by the variety of operations and involved materials. In most of the cases the machining is accomplished in machine-tool of numeric command, with constituted multiple tools of insert, holders and fixtures.The decisions for the selection of tools, determination of machining parameters and times of tool change are made by the process planners, programmers and machine operators in different stages of the production. Due to this share of responsibilities and to the interaction shortage with the process, it can become very difficult to accomplish good tooling decisions (Zhou and Wysk, 1992).

They exist many available tools which affect the acting of the operation, and it is not surprised that the tool selected by the operator it is not the great. Usually, the tools that are by hand and known, it is capable to carry out an operation in matter, and are used by convenience in spite of its disadvantages. The chosen tool can be far away from being together the great and this fact with the increase of the use of production systems integrated by computer it results in the need of automatic methods of selection of tools (Chen et al., 1989).

The main objective of the research work presented by Edalew et al (2001), was to develop the procedure goes the selection of cutting tools. The system comprised of several modulate; the knowledge acquisition modulates, the knowledge base modulates, inference engine, the user interface, and the database. By Edalew at. al (2001), tool material selection involves three. Stage one involves the component material selection. There are options for selecting material workpiece. The first option allows the user to select the workpiece material from the Cambridge material selector (Weaver et al, 1998), which is linked to the system. The second option allows the user to select the workpiece material directly from the material database, available in the system. The third option allows users to rely on its own knowledge and thus enter the workpiece material themselves.

In stage two, the user have to describe this selected material by inputting its mechanical properties such the hardness, Young's Modulus, tensile strength, thermal properties and the cutting temperature.

Stage three is based on the mechanical and heat properties of the material workpiece. The system provides the set of rules, which are used to select tool material type that would be suitable for machining this type of workpiecet material.

In a geometric simulation of cutting of the systems CAM, not only the generation of the path of the tool, but the tool selections are also important exits of the system. it affect the total time of machining and the area non cutting of the workpiece. A geometric simulation of cutting is important in the problem of selection of tools because the area to be cutting by the tool should be considered in the problem (Mizugaki et al. 1994).

The selection of cutting parameters is a very important stage in the generation of complete machining planning. However, that is not a very simple task, due to the volume and complexity of the necessary knowledge to the outlet of decisions (Coppini and Costa 1995).

In machining environment where the operator expertise goes decisive factor in the warranty that the correct tools were used for each operation this work model it is not acceptable in a modern machining workshop equipped with machines CNC for the following reasons (Zhang and Hinduja 1995):

- A great variety and a great number of tools are used for component to machining in machines CNC and the task of determining the group of tools correct becomes very complicated to be left for the operator of the machine;
- If the selection of tools is left for the operator, machine stops due to the incorrect use or of tools, become inevitable;
- due to the high cost of the tools, is not economical to allow tools to be kept individually in machine tools when it is not in use.

According to Zhang and Hinduja (1995), the task of toll selection should not only work correctly, but also can to be optimized, that is something very complex. It requests the development of sophisticated programs that should support databases which contain information on the machining resources and the practices of specific machining of the company.

If the geometry to be machined was given and the specified operation, the optimization of any cutting die depends on the cutting tool and of the machine. Consequently, for a given machine-tool does little sense to optimize the cutting data unless the most efficient tool is used (Maropoulos and Hinduja 1990). The modules of selection of tools attended by computer it have been developed in the sense of improving the speed, the precision and the efficiency of the search for the best tool.

Some systems usually treat of geometric problems that happen during the turning (Mizugaki et al. 1994), while others incorporate the cutting technology (Rho et al. 1992, Carpenter and Maropoulos 1994, Domazet 1990). Other systems of tool selection can include some cutting technology and still to offer a moderate geometric capacity (Eversheim et al. 1994, Hinduja and Barrow 1993, Maropoulos and Gill 1995) in situations where are necessary, more of some tools for if to machining a profile.

3. Proposed system

The ATOSS (Automatic Tool Selection System) is a system of cutting tools selection, developed in Delphi® 6.0 (in Windows environment), for use in job-shop, with the objective of supplying options of tools starting from the data supplied regarding the wanted operation, with the intention of selecting the best tool in function of the condiçõe necessary s for a given operation.

The system has a relationship with the database of the ISMA (Information System for Machining) developed in LEU/DEMAR/FAENQUIL and presented by Ribeiro et al., (2002). The program was especially idealized for selection of the best tool, aiming at the relationship cost/benefit/productivity in the beginning and in the moment of the development of the process.

However, the system also has the purpose of storing information on the cutting tools, mainly with relationship to the adjustment of the cutting parameters for typical situations of development of the process. Also has the objective of allowing the fast recovery of data when consulted.

According to the fig. (1), the system ATOSS was structured from way to select and to store the information regarding of the used tools used in the tests (holders and inserts); the suppliers of the several used items in the tests, the workpiece materials; the machines tools in which the tests were accomplished and the customers where there was the accomplishment of the tests.

The system can be stored the principal data of a research. Those data can be fixed, for instance: workpiece, machine, operation, etc., and the not fixed, for instance: cutting speed, rotation, tool, etc. All the obtained results are stored for each situation as produced workpieces, time cutting, roughness, etc.

3.1 General aspects of the system

For better visualization of the system operation its will be presented to follow some screens of the system, divided in way blocks to synthesize the maximum its presentation without hiding its potential.

To initialize the system it is typed ATOSS, the presentation screen it is shown (fig. 2), in which the options of machining operation (turning, driling and miling) are shown in the left window. Soon after when pressing any key of the window, turning, for instance, it is presented the screen of the fig. (3) then, where the several modules of information available are shown, as well as the special functions.

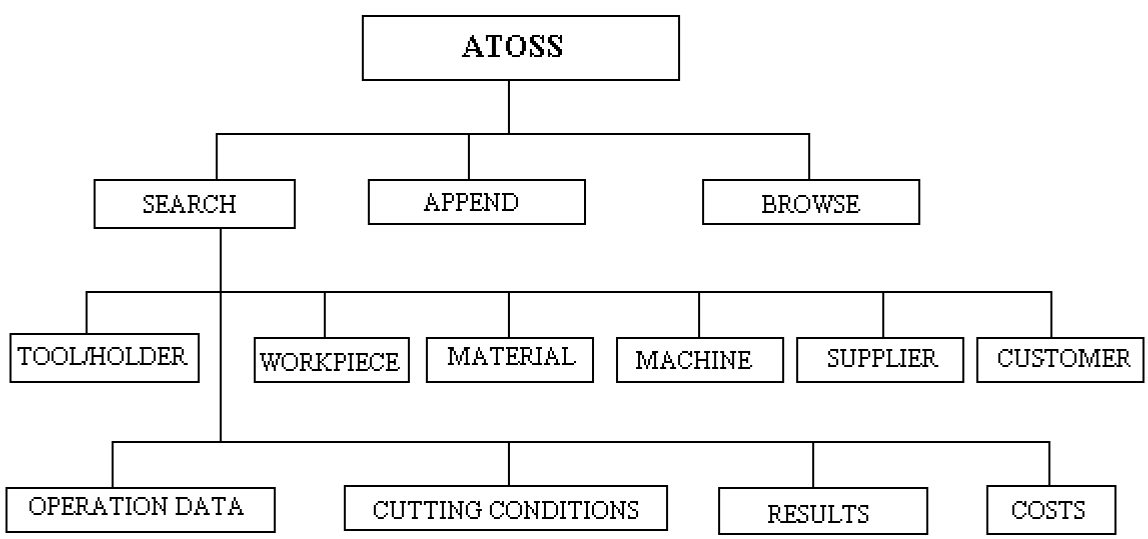

Figure 1. Modules of information of the system ATOSS.

Those special functions are: the append, the browse and the search. For each " click " in its respective icon of those functions a screen is presented. When clicking in the button append will appear to the screen of append turning of in accordance the fig. (4). The system it will supply like this of hourly order the append of machines, materials, tools, supplier, customers, workpieces, operational data, cutting condition and finally, results. The append forms a database of all possible information of the process and that can be browsed, analyzed and updated on-line. Reminding that functions are made by ISMA.

Figure 2. Screen of presentation of the system ATOSS.

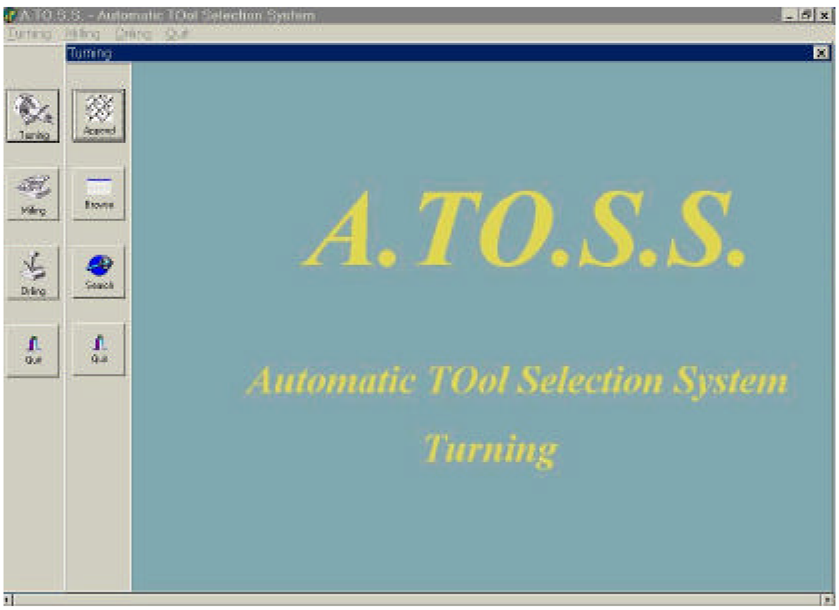

Figure 3. Screen of initialization of the system ATOSS.

To determine the preliminary information of a process planning system ATOSS presents those data starting from the characteristics of the product to be manufactured. In the fig. (5) the screen of input of the workpiece data is shown. In this screen the fingering boxes are presented where information as material of the workpiece, geometry, accessibility, and the number of sections is requested

The screen of data entrance regarding workpiece, shown in the fig. (5), it was projected to assist a keying method for code. That method facilitates the recovery of the information during a research in the database, avoiding change problems or misleading of data that it can happen during the researches.
The fields contained in that screen are:

- Code of the workpiece: that field contains 32 characters and it is responsible for the generation of the key of code of the workpiece.
- Denomination of the wokpiece: the companies, in a general way, has an internal control of the products that manufacture. That field has the purpose of registering the denomination of the workpiece used by the company, could be consulted in the future, through this denomination.

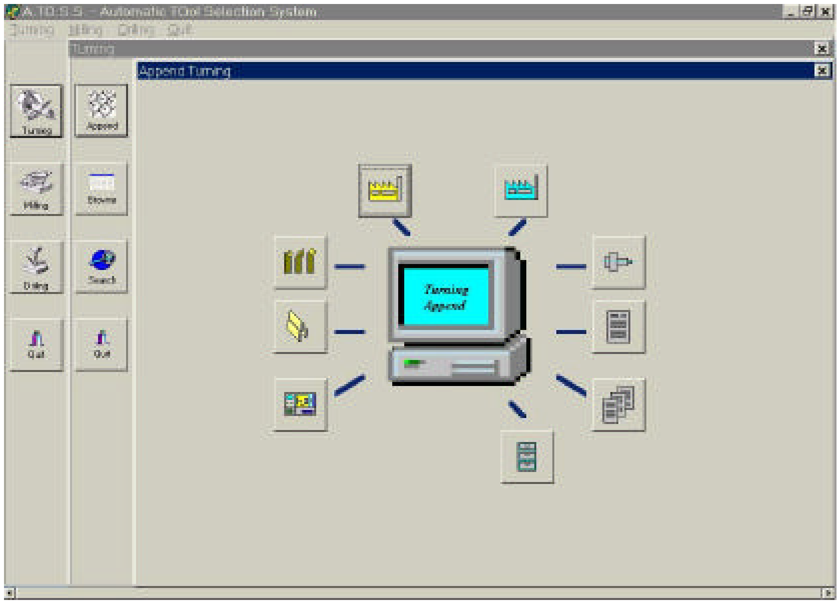

Figure 4. Screen of options of cadaster of the system ATOSS.

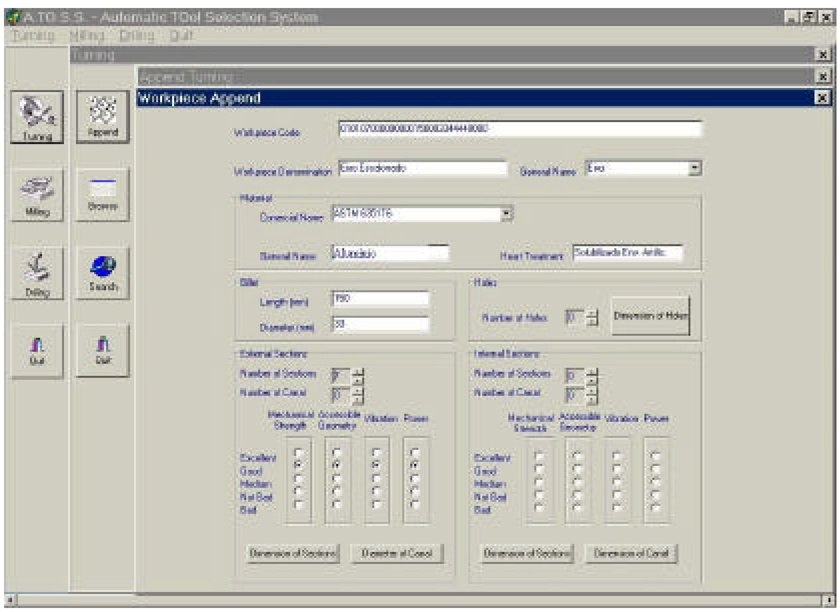

Figure 5. Cadaster screen of the workpiece to be manufactured.

- Name of the workiece: it will be shown in this field a list of generic names of workpieces known by the industry metal-mechanics. As it was explained previously is associated to the generic names of workpieces codes that aid in the generation of the key of code of the workpiece.
- Comercial name: the material used by the company in the production of its products and that it is registered by the system ISMA, it will be shown, in this field, through a list. When selecting the wanted material, the generic name of the material and the heat treatment that this material received are outstanding. That mechanism also participates of the generation of the key of code of the workpiece.
- Billet: actually there are two information that should be supplied to fill out this field and that are the maximum length and the billet maximum diameter. Those dimensions are also part of the composition of the key code of the workpiece.
- External sections: it is a group of information regarding the surface it expresses of the workpiece. In this group the fields number of sections, number of channels and a group of items that determine the characteristics principal of the exterior of the workpiece exist, with relationship to its production, that is, which the degree of difficulty that the workpiece offers to the tool, as complex geometry, mechanical resistance, etc. Those information are important for the system when a more appropriate tool it will select.

- Internal sections: it is also a group of information regarding the surface it interns of the workpiece. The fields number of sections, number of channels and a group of items that determine the characteristics principal of the interior of the workpiece also exist.
- Number of Holes: this item informs the number of existent holes in the workpiece to be manufactured.

The key of code of the workpiece is composed of 32 numeric characters. The position of each caracter has the purpose of representing the workpiece type, the material and used heat treatment, as the internal and external dimensions are willing and the characteristics of those sections.

To proceed, the disposition of the characters and its representation for the system:

00 - Generic name of the workpiece;
00 - generic name of the material;
00 - Type of trat term;
00 - Number of external sections;
00 - Number of external channels;
00 - Number of internal sections;
00 - Number of internal channels;
00 - Number of holes;
0000 - Length of the Billet;
0000 - Billet diameter;
0000 - *;
0000 - * *.

The last two groups of 4 (four) characters represent the degree of difficulty that the workpiece offers as the geometry, mechanical resistance, consumed power and vibration:

- **-** it represents the superficial characteristic it expresses, where the first number, leaving of the left for the right, it indicates the mechanical resistance, the second it indicates geometric accessibility, the third it indicates the vibration degree and the fourth number indicates the demanded potency. All those parameters vary from 1 at 5.
- * **-** it represents the superficial characteristic it interns, where the first number, leaving of the left for the right, it indicates the mechanical resistance, the second it indicates geometric accessibility, the third it indicates the vibration degree and the fourth number indicates the demanded potency. All those parameters vary from 1 at 5.

The geometry of the workpiece to be shaped is supplied for the ATOSS in the assigned form, that is, each section is considered an individual geometry based on the three basic geometric forms: conical, cylindrical and of curve surface. The position is also supplied in that is located the section in subject. The entrance of those information is made through the screem presented in the Fig. (6).

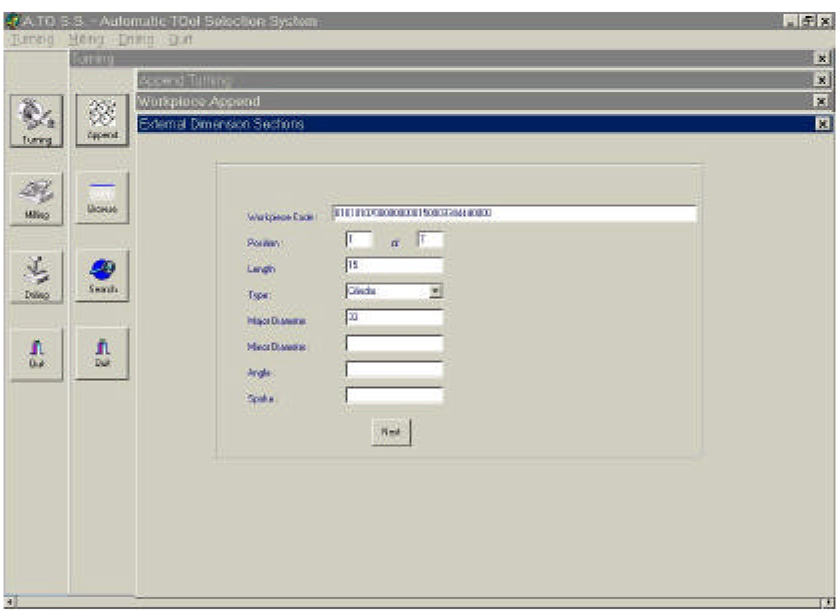

Figure.6. Screen of the positions and dimensions of the workpiece for identification of the system.

Another item to be registered is the cutting tool. The information linked in the registration of this item are important in the determination of the appropriate geometry for the wanted operation and its cost.

The format of the insert should be selected initially in function of the necessary position angle and of the accessibility demands and versatility of the tool. The largest appropriate tip angle to the insert should be selected, being taken into account the resistance and the economy. However, when progress direction has influence in the operations, the resistance versus the versatility, through smaller tip angles, it should be always considered. When it is made turning of profiles or cones of the coping, the maximum angle in copy should not be exceeded. A minimum rest of 2 degrees should be given between the face of the tablet and the surface of the workpiece. The nose radius of the insert is a factor-key with relation the:

- Mechanical resistance;
- Superficial texture in the finish.

For the rough:

- It should select the largest nose radius, to obtain an edge of robust cut;
- A largest nose radiius allows larger progresses;
- It should select the smallest nose radius, if there is tendency to the vibration.

The inserts are shown in the Fig. (7), with the angles of more common tip, of the round insert to the one of nose radius of 35 degrees. The scale 1 indicates that, with relationship to the resistance of the cutting edge (S), as larger the tip angle to the left, larger the resistance. With relationship to the versatility and accessibility (A), the inserts to the right are superior. The scale 2 indicates the tendency to vibration (V) it increases for the left while the power demand (P) it is lower for the right.

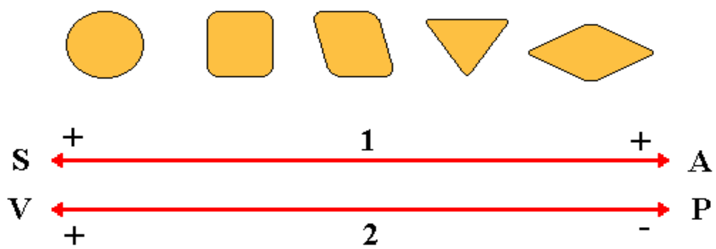

Figure 7. Inserts with the angles of more common nose radius, of the round insert to the one of nose radius of 35 degrees (Sandvik, 2000)

It was implemented, in the system ATOSS, those two scales of nose angles of the inserts but with the definition of vibration degree, power, accessibility and resistance. In the fig. (5) it is shown as that information it is supplied for the database, in other words, that shown illustration is the one of workpiece cadaster, in the which the referring information to the selection of tools also exist.

In agreement with the human interpretation, the scales were implanted as degree, Excellent, Good, Medium, Regular and Bad, respectively.

For the mechanical resistance, understands each other as Excellent the capacity of the tool to support the largest mechanical efforts during the machining operation, and Bad as the capacity of the tool to support small efforts mechanic.

For the versatility and accessibility, understands each other as Excellent the capacity of the tool to make complex geometries that demand a very small nose radius, and Bad it determines the access difficulty in certain geometries.

For the vibration, the scale implanted in the system, understands each other as Excellent the smallest vibration degree that the tool can produce, and Bad it indicates that the tool will produce vibrations in agreement with the parameters of adopted cutting.

For the power the scale adopted Excellent it indicates that the tool doesn't consume a lot of potency during the usinagem process.

The system, as already showed previously, allows the research starting from the information regarding the operation of choice of the tool, as it is shown in the screen of the fig. (8), to proceed. As in that example, that screen is answer of the workpiece machined with itsr chosen tool and its holder that it is viable, that is, that gives conditions of looking for all the possible positions of the proposed workpiece, and some are also shown cutting parameters, as feed, depth, speed and rotation.

The geometry of the workpiece as already commented it is divided in sections in agreement with the profile (cylindrical, conic or curve surface) and its dimensions.

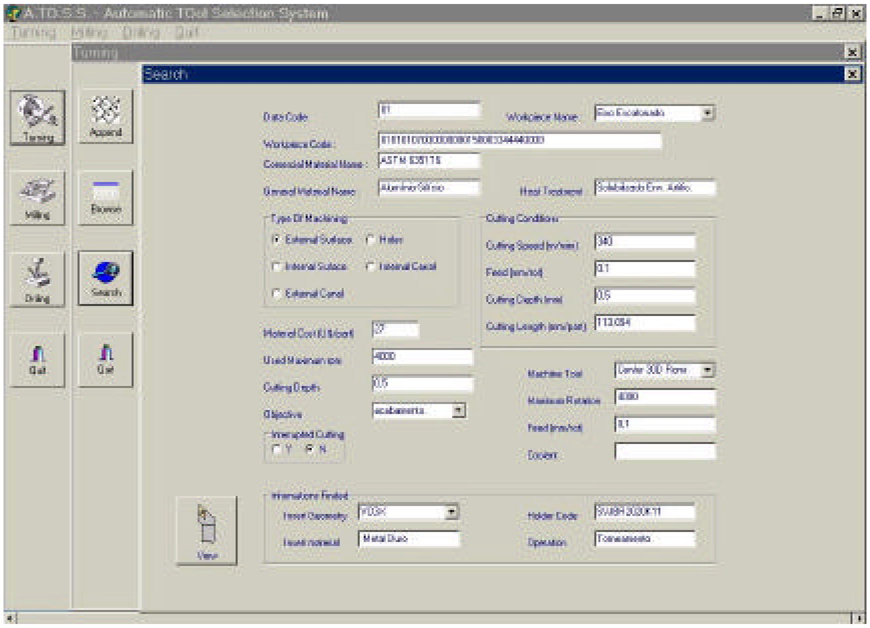

Figure 8. Screen of the positions and dimensions of the workpiece for identification of the system.

5. Discussion

The system ATOSS in development makes possible advantages for the user. The characteristic principal of the presented system is of being program objects-oriented. Most of the users has the capacity to store visual information, and other people need handling of those information through manual systems for best to familiarize. The programming guided to objects form versatile systems and of easy access, because itpossess all manual and visual characteristics, for instance, mouse, visual programs with its respective fields that can be filled out. With a simple click the system is worked liberating the screens that can be worked the and consulted. The information can be typed in its respective fields. its fields have certain sizes and properties being text or number. Some information in the databases are fixed, not could be modified, for instance, tools characteristics material. The types of information don't fasten its is, for instance, the data of cutting condition: speed, feed, depth, etc. Each workpiece to be registered will have a keying code with having discussed previously, this proposed way of the a larger safety for the operations, since depending on the material, of the geometry type will have its specific code.

The programming is being made in Object Pascal language. A advantage of that language is the standardization of a group of basic resources, although some syntax rules can vary of an implementation for the other. This means great part of the learning and it facilitates the conversion of programs among different equipments. This language allows to create and to manipulate arrangements, registrations, groups and files, the dynamic allocation of variables with aid of sharpeners, the declaration of identifies for constants, the use of procedures that read and it write individual campus instead of complete registrations, the use of functions and procedures recursivos, etc.

The system implemented in Delphi® 6.0 it presents a other advantage, because he didn't possess problems with other systems, in other words, problems with different platforms. Borland Delphi is a program oriented to objects, and the programming is made in visual invironment. Its applications dispose in invironmen Windows and Linux. Delphi supplies an including class of called library of Visual Component Library (VCL), Borland Component Library for Platform (CLX), and a group of tools of drawings Rapid Application Development (RAD).

The system ATOSS, have a link with databases. The information are stored of the processed operations in on line. Those information are important, because can be used in a comparative way in future operations, winning with that time and quality, in other words, same data or seemed it can be used aiming at an otimização of the operation.

The system as shown it uses the for section of the workpieces facilitating the choice of the holder optmization and of the ideal insert, because for each section it can demand an ideal holder. Also in function of the type of material of the workpiece, property, heat treatment a tool in agreement with the logical algorithm the tool will be selected.

The answer screen or of research, it contains necessary information for each operation to be developed, as for instance, the type of registered machine, therefore owed the characteristics of the own machine a holder type it should be used, besides information as the rotation of the machine. In that same screen it have a button that makes possible to visualize the geometry of the mounted tool and the important information.

That automatic selector of tools allows the user it to consult data of the operations in real time or referring data to passed processes. The option in the case Browser maintains the attentive user of that that was proposed in the beginning of the selection.

Therefore, the system proposed in development it has advantages for the user and a contribution in systems of plannings of processes aided by computer.

In the academic area or in relation to its contribution it is being great importance, because the knowledge of the sciences of the materials, of the machining forces in process, of the analyses of roughness, of the geometry of the tools and workpieces, of the effects of the variables in machining, it trace the logic computacional, in other words, if the selection of the tool doesn't obey the conditions proposed in the algorithms it won't happen, then the system will make a loop until that is completed wanted.

6.Acknowledgement

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