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METALLOGRAPHIC SAMPLE PREPARATION STATION-CONSTRUCTIVE CONCEPT

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***Abstract*—** In this paper we propose to present the issues involved in the case of the constructive conception of a station for metallographic sample preparation. This station is destined for laboratory work.

The metallographic station is composed of a robot ABB IRB1600, a metallographic microscope, a gripping device, a manipulator, a laboratory grinding and polishing machine.

The robot will be used for manipulation of the sample preparation and the manipulator take the sample preparation for processing.

***Keywords*—**Metallographic, polishing machine, grinding machine, sample preparation, constructive concept.

I. Introduction

IN recent industrial advancements we can observe a tendency to focus on the increasing need for quality and precision. The research critical requirements such as repeatability and accuracy while also keep the time duration as short as possible led to the implementation of new autonomous control systems, according to Csokmai, Moldovan, I. Tarca, R. Tarca [1], Csokmai, Moldovan, I. Tarca, R. Tarca [2] and Pasc, R. Tarca, Popentiu-Vladicescu, Albeanu [3]. The price of a fully equipped metallographic analysis laboratory is not always a justifiable cost for small production companies, on the other hand, such services can be outsourced to other companies or research institutes how to have the equipment and can offer the specializes services. In the industry of metal machining, there is a need for metallographic analysis laboratories in order to perform analysis and control; this planned verification is made in order to assure consistency in the mechanical for different batches of parts. The stage at which the metallographic analysis is done can differ, in some situations it is possible to do a test before processing a given part. One example will be analyzing the surface or microstructure of the sample if it is appropriate for a certain special process. Metallographic tests can also be done after different phases of processing, like milling, thermal treatment, welding and so on. In essence, processes that can modify the microstructure of the metal during manufacturing phases, as presented in Vesseleny [4] and Moga, Vesselenyi, Tarca [5].

Most laboratories have the opportunity to do the metallographic analysis and control using the typical and manual approach. A key important factor for any investment or service, such as *specialized* metallographic laboratories is using the most efficient and cheapest method without risking the validity and accuracy required. Systems that implement a degree of automation with the aid of robotic methods are very well implemented for many areas in the industry, this is due to higher precision results and heightened productivity. In the domain of metallographic analysis, implementation of an automated system creates a more efficient quality control, but it also reduces the manual labor done in the past by humans, enabling laboratory stall to focus more on the research of the results, according to Kelly, Field, Thomea [6].

II. Theoretical aspects

A. Computer-aided design (CAD)

Computer Aided Design (CAD) is currently increasingly used more often in very different areas, some experts considering that this technology has reached maturity. But the recent transformations of major computer-aided design systems prove that the CAD software field is still evolving. Improving the general architecture and adding new functions and tools for modeling systems, improving the user experience and ability to easily create solids, surfaces, and geometric patterns, based on the parameters indicated by the designing engineer.

B. Main methods of design

For design we can distinguish two major methods in which a project can be achieved:

1) from bottom to up;
2) from up to down

1.From the bottom to up design is the classic method of development in the domains of electronics and mechanics. Schematically this design method can be seen in fig. 1.

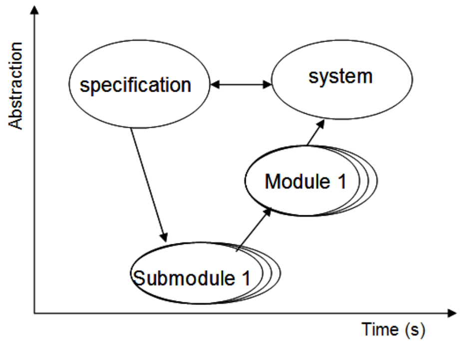

Fig. 1. From bottom to up design method principle.

In this design method, the initial point of departure is a specification. Then the core components, for example, transistors, resistors, capacitors for electrical circuits or, ball bearings, gears springs, dampers, etc. for mechanical systems. They are added successively and combined to form the creation of an increasingly complex system in forming the complete design. This occurs at a structural level, so the only thing that is determined each time are sub-modules that make up the module and how they are connected together. Such a project can be performed using an editor circuit or an appropriate tool for multi-body systems.

An issue about from bottom to up design method comes to specifications for design, after she had taken a diversion by sub-modules abstract from functional described. This is due to the fact that as a result of the structure-oriented modeling, a system can be simulated only when it has been fully implemented.

Thus, errors and deficiencies in the system design are not observed until a later stage, which can bring considerable cost and delays.

2. From the up to down design has a significant design characteristic, namely it has a predominant direction flow from the abstract to detailed descriptions. In fig. 2 it is shown schematically from up to down design methods.

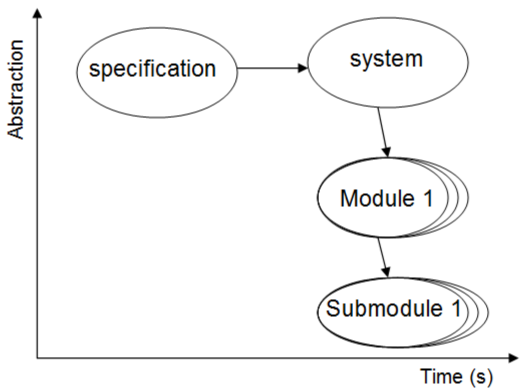

Fig. 2. From up to down design method principle

The starting point is a purely behavioral model, by which already covers a good part of the specification.

The model is partitioned and refined until a successive implementation.

This design method has several advantages over the previous method:

1) errors and weaknesses in the design are seen early, in contrast to a bottom-up approach.

2) the specifications implemented can be validated by simulations.

3) the implemented specifications are available as a reference for verifying precisely defined project.

4) implementation patterns and specification design of individual steps means that complete documentation is available, which, however, remains to be completed a comprehensive review.

In the case of the mechanical domain, from up to down design sequence is still in the development phase.

III. DESCRIPTION OF CONTRIBUTIONS

The useful concept was done using the *bottom to up* design method, previously described.

The virtual model was made using CATIA V5 software.

The following components of the station were selected based on the principles describes in Pelz [7], Tarca [8] and Tarca [9].

1) sample with dimensions consisting of length 20(mm) and diameter 20(mm);

2) a robot, type ABB IRB 1600 ;

3) two gripping systems made from Schunk company, type PGN 100;

4) a grinding and polishing machine, with two working posts;

5) a mechanically joined consisting of a rodless cylinder, type MY1B63-1100 manufactured by SMC. The cylinder has the following dimensions: diameter of cylinder 63(mm) and stroke 1100(mm);

6) a rotary actuator, type CRB1BW63-270S, the diameter of the cylinder is 63 (mm) and stroke is 270 degrees, made from SMC company;

7) a linear cylinder with guiding columns, type MGPM, the diameter of the cylinder is 50(mm), and stroke is 40 (mm), made from SMC company;

8) a metallographic microscope, with stepper motors for X and Y axes;

All these elements exist in the laboratory.

Besides these items for the entire station we need:

1) Storage for processed and unprocessed sample parts.;

2) a working post for alignment sample part by grinding and polishing machine surface by manipulator;

3) a working position for water cleaning;

4) a working position for acid treatment;

5) a framework for mounting linear cylinder MY1B63-1100;

6) two jaws for gripper on the robot;

7) two jaws for manipulator gripper;

8) a table for grinding and polishing machine, for working post for water cleaning, for working position for acid treatment, for storage, for working post for alignment sample part by grinding and polishing machine surface and for the microscope.

9) some connection plates.

The entire station it is presented in fig. 3 and the components who see in this figure are: 1 is the robot which is mounting the gripper 2, 3 is a storage for processed or unprocessed sample parts, 4 is the manipulator for sample parts, 5 is - a grinding and polishing machine, 6 is a working post for attacking with acid, 7 is a working post for water cleaning, 8 is a metallographic microscope, 9 is a table, 10 is a working post for alignment sample parts.

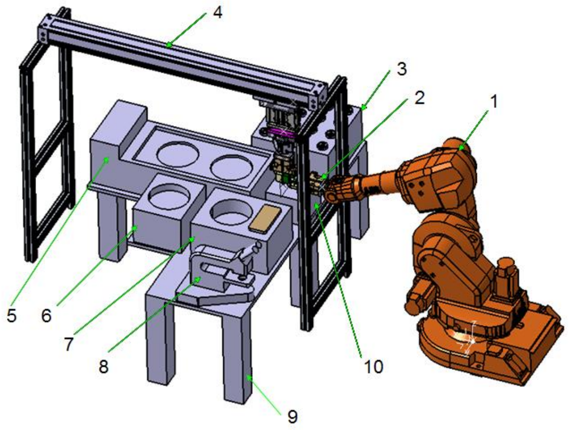

Fig. 3. Metallographic sample preparation station. Layout

For system functioning, the human operator put the unprocessed sample parts in the storage. The storage has 16 places, 8 for unprocessed sample parts and 8 for processed sample parts. In fig. 4 it can be seen:

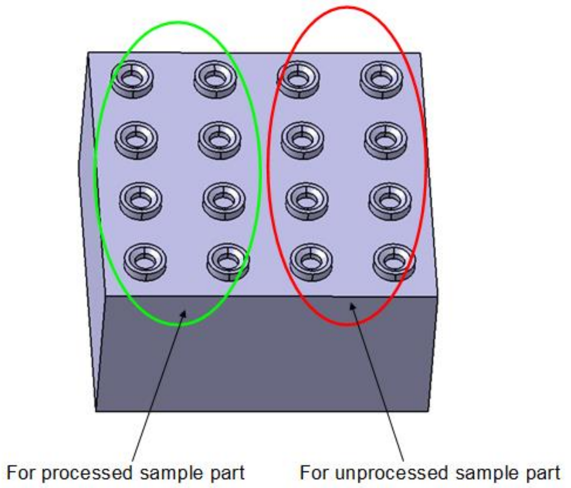

Fig. 4. The storage for processed and unprocessed sample parts

The diameter places for the processed and unprocessed sample parts are made by 0.1(mm) bigger than maxim diameter of the sample parts.

After sample parts have been positioned in the storage, the robot takes one by one sample for put on the working post for alignment sample, because this robot is RRRRRR type, alignment surface of the sample part which is for processing with grinding and polishing machine surface is not exact. And for a correct alignment is necessary this work post.

The gripper makes fixing by form and force. Fixing by force is made by means of gripper system. Fixing by form is possible because the jaws of the gripper are prismatic. In fig. 5 it can be seen:

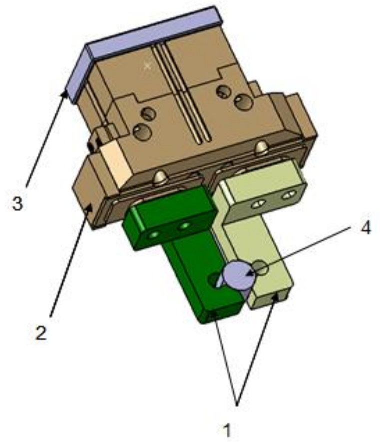

Fig. 5. The gripper for manipulating sample parts by a robot. 1- prismatic jaws; 2 Schunk PGN 100 gripping system;3- connection plate; 4- sample part

After the alignment surfaces are done, the manipulator takes the sample parts from this working place by means of the second gripper, which use the same principle for fixing as the previous gripper, the sitting shoulder for sample and the sample orientation is the difference here.

The manipulator is presented in fig. 6:

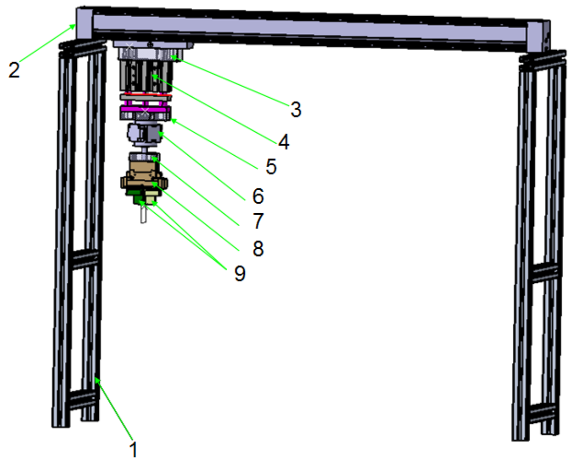

Fig. 6. The manipulator
1- framework; 2- linear cylinder without guiding columns; 3- connection plate; 4- linear cylinder with guiding columns; 5- intermediate plate; 6- rotary actuator; 7- intermediate plate; 8 – gripping system; 9- prismatic jaws

This manipulator is provided with three working positions: the first position is for taking the sample parts, second and third position are for processed because of the grinding and polishing machine, has two working posts. This issue can be solved by linear cylinder, position 4 in fig. 6.

The first problem is, in this case, the pressing force for sample parts because those two working posts of the grinding and polishing machine execute a rotating motion for processed and the force must be big enough but not very big. This issue can be solved by a linear cylinder with guiding columns, position 4 in fig. 6, by controlling the pressure on both inputs of the cylinder. This cylinder is the compliance module for manipulator

The second issue is the direction of polishing of sample parts: if not rotates 90 degrees sample parts in a time of polishing, the polished surface will be full of traces of polishing disc. To avoid this problem we used a rotary actuator which can make a rotation of 270 degrees, position 6 in fig. 6.

The third problem in the case of this manipulator is to ensure a firm position of sample parts in the gripper of the manipulator. A useful form of the gripper jaws solved this problem according to Staretu [10]. In fig. 7 is presented this gripper:

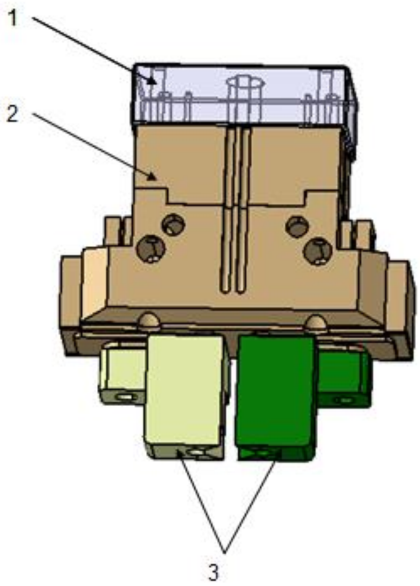

Fig. 7. The second gripper of the metallographic station
1 - connection plate; 2- gripping system; 3- prismatic jaws.

As the first gripper, this makes fixing by form and force. The prismatic jaws are designed from hard plastic, and the form is visible in fig. 8.

Support area for sample parts is a machined surface for fixing sample parts along own axis because the manipulator must press on perpendicular own axis direction.

The fixing area for sample parts made from fixing.

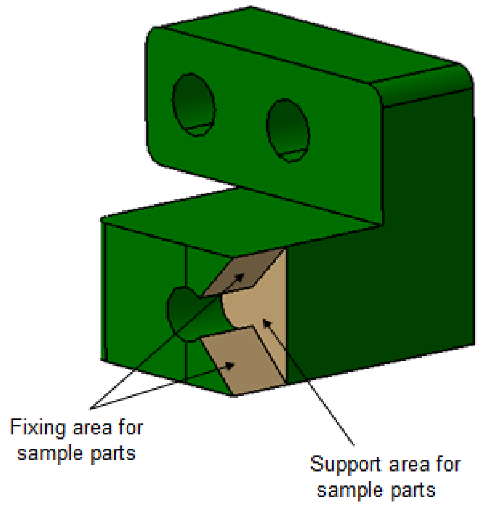

Fig. 8. A form of prismatic jaws

IV. CONCLUSION

As a conclusion, we can say that are fulfilled all conditions for achieving a modern and performance metallographic sample preparation station.

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