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TRIBOLOGICAL AND ECONOMICAL ASPECTS OF DEALING WITH FIXTURING TOOLS

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The study contains results of theoretical considerations regarding tribological and economical aspects of dealing with fixturing tools. Tribological and economical aspects of dealing with fixturing tools were analyzed using special and modular-flexible fixturing tools. As a result of performed analysis, with respect to contemporary world trends, the conclusion was reached that in contemporary production conditions modular-flexible fixturing tools are in growing demand due to tribological and economical aspects. On contrary, domestic metal working industry is characterized by low application level of modular-flexible fixturing tools, as well as large number of objective and subjective reasons related to it. The objective of the study, in the first place, is presenting the facts clearly indicating, regardless the objective problems, that modular-flexible fixturing tools and the need from the economic point of view are profitable.
Key words: special tools, modular-flexible fixture, wearing, materials, costing price

1. INTRODUCTION

In every machining process, besides tool machine, tool and measuring equipage, as inseparable material factor there is fixture too. Fixtures in metal cutting, no matter a type of fixtures, have a function to do uniquely and reliable positioning and clamping workpiece. Reliable positioning and clamping workpiece in big proportion contribute the quality of fabricate parts and through the process of design fixtures presents one of the basic principles for good design. Fixtures in operations of metal cutting might be special, universally, grouped and modular-flexible tools.

Basic principles of applying, design and assembling fixtures, from aspect of possible faults production parts, stay the same, no matter the type of fixtures. Theoretical analysis possible faults of productioning parts (positioning faults, clamping faults and machining faults), with respect to way of positioning, clamping and distribution of loading, present the necessary step in analysis and designing fixtures, without respect of type of fixtures. Operations of metal cutting can be doing with applying of special, universally, grouped and modular-flexible tools. However, applying mentioned groups of fixtures, have its advantages and disadvantages from aspects of some outgoing effects of machining process (costing price, productivity, efficiency). In many aspects, it is very important to make the analysis of advantages and disadvantages special and modular-flexible tools which present two the bigest and most widely groups of fixtures.

The special fixtures, utilize modeling and made for special manufacturing operations are most wide in domestic metal industry, until the using modular-flexible tools are widespread in all aspects of manufacturing in the modern world (single and serially manufacturing). Very low level of using modular fixtures in domestic metal industry, have a very much negative

consequences, which is proved through the problems of changing manufacturing programes and very often give uncompetitive quality and very high costing price.

The purpose of this paper is to present an advantages of applying modular-flexible fixtures and objective needing of their implementation in domestic metalmanufacturing industry. This work has the descriptive character and touches only some elements associated for tribological and economic aspect for applying modular fixtures.

2. ACTUAL TRENDS OF DEALING WITH FIXTURES

Actual trends of dealing with fixtures are based on maximal applying modular-flexible fixture. Modular system of fixtures is designed to make possible assembling variety of types fixtures based on finished elements. In industrial extensive countries, and partially in this country, existed many firms which manufacture the fixtures sets for many purpose [5, 6]. Basic groups of parts (basic plates, stakes supports, basic elements, leading elements for cutting tools, pressing assemblies etc.) and wide variety of dimensions and shapes of parts make possible assembling-composes fixtures with different shapes and different purpose. Due to wide variety of dimensions and shapes and resource of groups of parts it is possible with very big probability make assembly for every one fixture with 100% applying finished elements. Assembling fixtures with applying finished elements, today in world is carry on with computer aid. Based on formed finished elements bases and suitable software package, the process of automatization become extensively automated [1, 2]. Everything previously mention, prove that industrial extensive countries pretend to spent a less time as possible from needed to realization fixtures, with minimum cost. Enormous number of extensive systems cover domain of parts with small, medium and big dimensions and machining on modern NC machines, in conditions of single, serial and even mass manufacture. It is very difficult, by reason of complex problem, show a small part of possible solutions of fixtures, which are measured by thousand elements with different shapes and dimensions. For example, fig.1 illustrated assembly of fixture composed with finished elements.

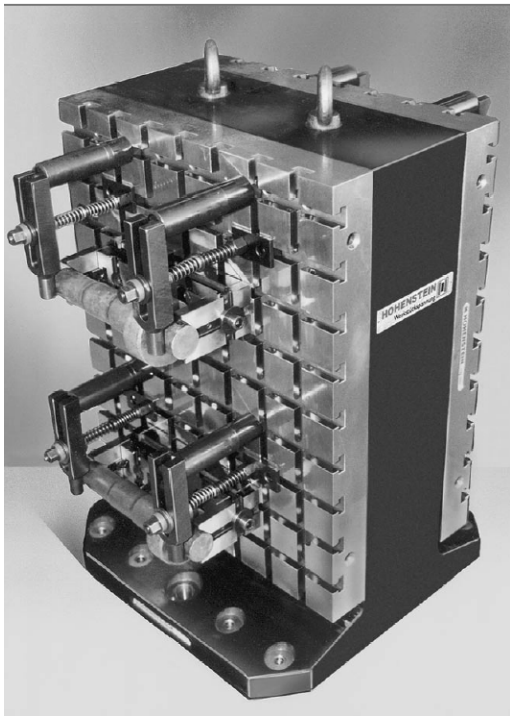

Figure 1. The example of modular fixture assembly

One example of modern fixture assembly with four pressing spindles, is shown on fig 2. The characteristic of this device, is very high flexibility and ensures settings different basic elements in fixtures space. We must give the accent, that precision of settings steps of spindle is only 0.5μm.

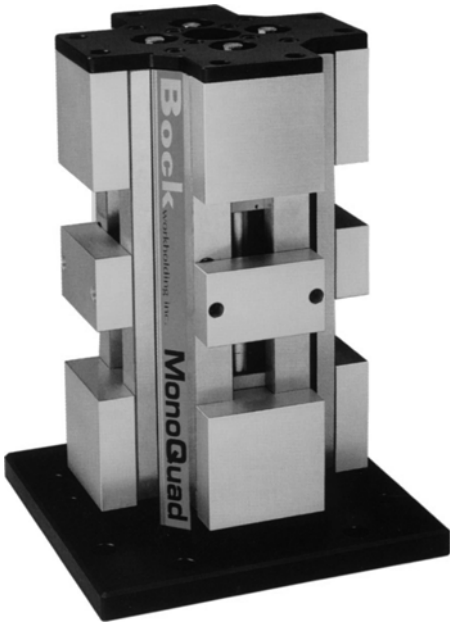

Figure 2. Modern fixture

One example of very high flexibility fixture system [3] is illustrated on fig3. and fig4. This system, based on supports, enables locating and clamping in wide range of workpiece dimensions in every point acceptable for locating and clamping.

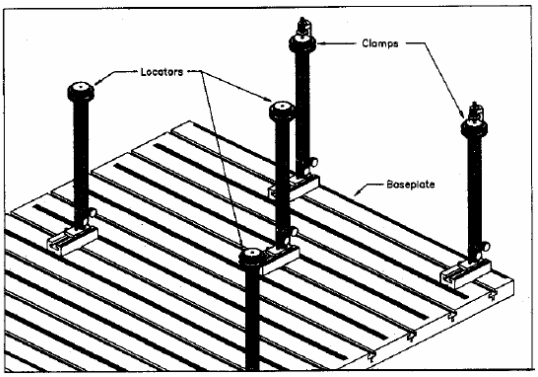

Figure 3. Support based modular fixture system

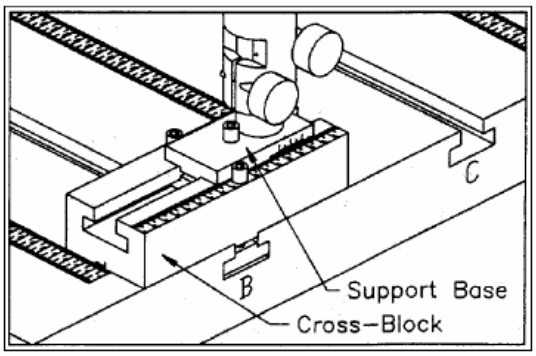

Figure 4. Detail of support

Showed illustrations of fixtures systems, point out the trends of developing modular fixtures systems, primarily increase of their flexibility.

3. TRIBOLOGICAL ASPECTS OF FIXTURES

Tribological aspect of designing fixtures, presents very important domain. This includes:

- Applying of new materials and
- geometrical precision and quality of finished surface.

The dominated materials, used for fixture production, are often many sorts of steels. The carbon steels are mostly used as material for locating elements (basic plates, locators etc.), while for clamping elements are used heat treated steels.

A new construction's elements of modular fixtures (fig5) are made of special aluminium's alloies [7]. Applying of aluminium construction, has big importance from aspect of oscillating the system workpiece-fixture.

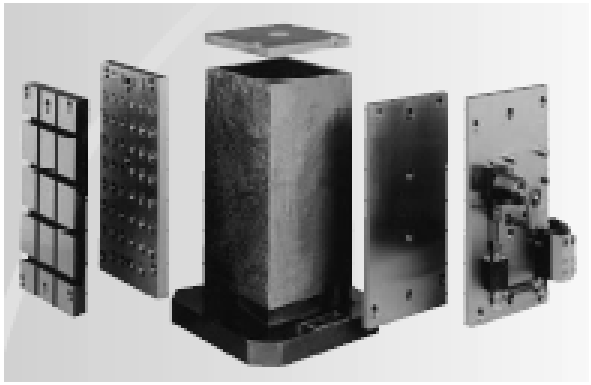

Figure 5. aluminium's stake support armatures of still plates

Previous example of stake support (fig 5.) made of special aluminium alloies according previously studies [7] show reduction the level of vibrations and ten timescompared to stake made of steel. We must not consider fixture as static construction, because fixture represent dynamic construction which due to action forces of cutting on workpiece, workpiece oscillates with determinated speeds and amplitudes of oscillate. The oscillation's speeds and amplitudes are in directional proportion with preciseness realized dimensions and surfaces quality of workpiece. This solution stake support, made of special aluminium alloies provides very high toughness of workpiece surface. Locating and clamping elements, are based on side surfaces of stake's support and made up of properly thermical treated steels, but their masses are much less then the mass of whole construction, which contributes to better way of oscillating.

Modular fixtures are made with very high quality of geometrical and surface precision. That things give the contribution to very high precise of assembling fixture, better contact between surfaces of fixture and more reliable of the whole assembly of fixture.

4. ECONOMICAL ASPECT OF DEALING WITH FIXTURE

Modern manufacturing aims are to achieve high productivity and to reduce unit cost. This necessitates workholding devices to be efficient,

i.e. to increase the rate of loading and unloading to speed up the manufacturing cycle time.

If ***t*** is the total time in second s or minutes required for production rate [6] : then

$Q = \frac{1}{t}$ is the number of pieces produced in unit time , or the production rate.

Total manufacturing time is usually composed of:

$t = t_m + t_h$, where: t_m – actual machining time; t_h – is the setting up and handling time.

Number of pieces per unit time:

$$Q = \frac{1}{t_m + t_h}.$$

Supposing **Qt** is the ideal production rate whereby there is no handling time loss for a given machining operation, hence we have:

$Q_t = \frac{1}{t_m}$, now,

$$Q = \frac{1}{\frac{1}{Q_t} + t_h} = \frac{1}{1 + \frac{t_h}{t_m}} \cdot Q_t = \lambda \cdot Q_t,$$

This factor $\lambda = \frac{1}{1 + \frac{t_h}{t_m}}$ can be termed as production efficiency.

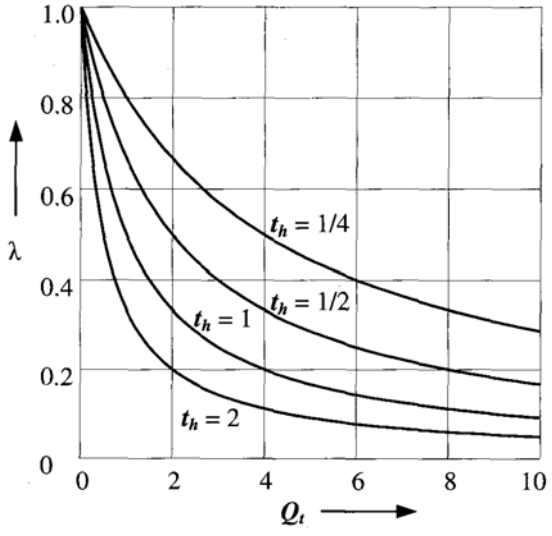

*Figure 6. Effect of setting and handling time(**th**) on production efficiency (**λ**)*

The variation of **λ** with respect to **Qt** is shown in figure 6., for the various values of **th.**

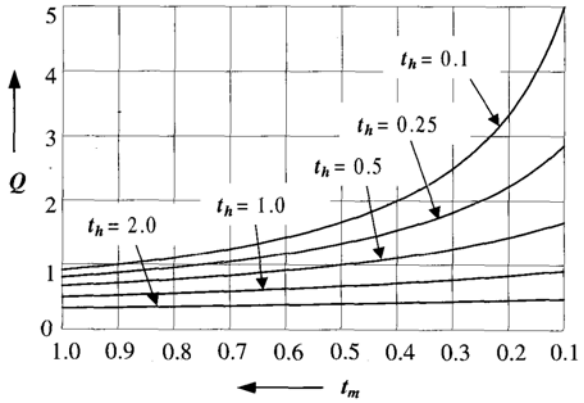

Figure 7. – Effect of setting and handling time (th) on production efficiency (λ)

In comparison between special and modular fixtures we can conclude following:

- modular fixtures need less time for assembling of construction. Designing time and producing time is minimal or simply it does not exist. Construction is forming by aggregating of finished parts and with computer database aid and software support,
- the time needed for producing of fixtures practically does not exist, because there are ready-made completes. It contributes to fast transition from one manufacturing program to another, and with that it can be answered to serious requirements of modern market,
- modern modular fixture systems are equipped with fast acting fixture subsystems, what reduces setting-up times and it increases efficiency,
- modular fixtures of newer generation are characterized by high reliability of elements through high quality of elements and construction stability. It contributes to significant reducing of down times in manufacturing in comparing to special fixtures, where downtime is more present because of a large possibility of fails in designing and producing,
- nowdays, modular fixtures are present in all types of manufacturing, in other hand special fixtures are not present,
- from elements and assemblies of modular fixtures, it can be, on relatively simple way, formed grouped fixtures, what is not the case with using of special fixtures.

Based on previous discussion, modular fixtures are belonging to mounting-unmounting type, where the same elements, subassemblies and assemblies are used for forming of different fixtures. It means, beside flexibility and reliability, the manufacturing operations and complete manufacturing is less loaded with expenses.

One of the basic problems of more applying of modular fixtures in local metalprocessing industry is adequate level of starting financial investments and time for refounding of resources. Beside that, there is more problems connected with missunderstanding of competent public in advantages of modular fixtures exploiting during the period from three to five years. The significant number of local metalprocessing companies, in their own factories are designing and producing fixtures for their own needs. Those fixtures are more expensive, but in lower quality than the fixtures made in specialized factory. From these reasons, often, the large number of special fixtures after certain product became out, is totally inapplicable. In this case, it is necessary to emphasize that large number of modular fixture elements could be purchased by acceptable prices, specially in case of parts which are produced in high series (screw parts of standard and special design, clamps, leader pin, elements for locating etc.).

5. CONCLUSIONS

Based on previous discussion we can conclude that modern industry couldn´t be realised without applying modular fixture. Nowdays in industry, are developed great number of modular fixture systems. High quality design of elements, subassemblies and assemblies of modular fixture characterize high reliable, shorter time of physical work for assembling construction and acceptable price. In significant number of analyzed cases which are not exhibited in this paper, the price of modular fixture, might be less then the price of special fixture, even and if we not account multiple applying elements of modular fixture. The bigest problems in our metal industry are permanent deficit of material resource and high prize of products and as consequence, loss big part of the market . Just from that reasons, it is necessary to make conditions for better application of modular fixtures. Beside the mentioned problems in local metalprocessing industry, there is the problem of inefficient knowledge of experts in dealing with modular fixtures. Partially it could be solved at company level, what demands graduated transition to modular fixtures through constant education of skilled stuff. The education leads to adequate choice of construction elements and construction design with using of computer equipment. The problem could be solved also, through uniting of certain number of companies with common supply and usage of modular fixtures. In such way, the frequency of the modular fixture completes usage is higher, and the expenses of producing are lower.

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