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THE INTELLIGENT FIXTURE AT FLEXIBLE MANUFACTURING

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ABSTRACT: Development of new generation production machines and systems demand that they are equipped by adequate fixture devices. These fixture devices are developed with machine together, to don't decrease their production facilities and their time and performance utilizations. Efficiency of fixture device in automatized production systems underlie using efficiency of entire production systems. The majority of actual production is small or middle batch character. Thence, using of flexible production systems has lot of advantages. Their new generation fixture devices different from classical fixtures not only by design but also by its properties.

KEYWORDS: intelligent fixture, flexible manufacturing, clamping, intelligent manufacturing

❖ INTRODUCTION

Before 70th years of last centuries the mass production respond to basic requirements of market, but after this get started consumer affect the market. The producer must adapt to consumers requests and get started production of some variants of its products. This changeover has significant impact to mass production. Producers who can produce the wild range variants of its product have domination at market. This trend in production continues to present time. Today market is characterized by strategy of consumer's individualization. This strategy is oriented to consumer's requests. Consumers want new products and time has a fundamental task to its satisfaction. The production was broadened, innovation cycle is shortened, the products have new shape, material and functions. At this strategy the traditional understand of costs lost in importance. Most important is a time and improving is its shortening. The production strategy focused to time need change from traditional functional production structure to production by flexible manufacturing cells and lines. Production by flexible cells (FMS) is a most important manufacturing philosophy in last years. This philosophy is based on similarity:

- ❖ similarity of manufactured parts,
- ❖ similarity of process plans.

Recognize the similarity of manufactured parts allow grouping them to groups by machines required to its manufacturing. By manufacturing of this group of parts we achieve economical effect near to mass production.

The manufacturing cell is an open manufacturing unit with transparent manufacturing processes. Flexible manufacturing cells represent a today trend to manufacturing innovations and productivity increasing. The clamping fixture provides clamping of workpiece on machine desk, so as the workpiece have the right position toward a tool. This position must be retaining in machining time too.

Fixture using increasing the production quality, the productivity and decreasing the production costs. In some cases are fixtures using necessary. The fixture design is dependent on the batches of production. In small batches we use the fixtures designed from modular system and in large batches we can use the dedicated fixtures.

The clamping fixture providing these basic functions:

- ❖ workpiece positioning on the desk of machine,
- ❖ to prevent of workpiece deformation when cutting and clamping forces are acting,
- ❖ tool support (in some cases).

These functions are provided by positioning, clamping and supporting elements (active elements) of fixture. These elements can be placed on standalone unit or on some units or can be mounted to machine or some its part.

Automated technological system must ensure required product quality by their properties and parameters without human action. Consequently all subsystems automated technological systems are participated to provide for required quality with different but function dependent deals. For automated technological system production quality requirement assurance are needed correct decomposition functions between individual subsystems ATS, their time and position synchronization. In this process are needed respect dynamic shows and compatibility bilateral inputs and outputs of technological process in ATS.

❖ FLEXIBLE MANUFACTURING

The flexible manufacturing cells are characterized by high level of manufacturing process automation. They are used mainly in middle batch production (500 - 2000 pieces of products) and for middle products range (5 - 100 types of products).

The supplementary devices are used mainly to manipulation with workpieces and tools:

- ❖ workpiece storage and device for workpiece changing,
- ❖ storage, controlling and changing of tools,
- ❖ quality control.

A part of complex automated manufacturing process is an automation of technological process control, automated transportation, handling, feeding, interchange of workpieces, tools and automated waste cleaner. There are many technological sites existing, which match given requirements. Besides obvious computer techniques for controlling the manufacturing machines, automatically working bins, loaders, conveyors, manipulators and industrial robots are implemented step by step. As industrial production is growing constantly, besides implementing of the classical automated means, which were mentioned above, manufacturing systems with intelligent control are being installed.

Exploitation of automated manufacturing systems is conditional by effectiveness of all subsystems, from which is the automated manufacturing system created. All subsystems are often developed together with certain automated system, not to decrease parameters of whole system.

❖ INTELLIGENT CLAMPING FIXTURE AT GENERAL

The majority of actual production is small or middle batch character. Thence, using of flexible production systems for these types of production has a lot of advantages. The flexible production systems must have a flexible clamping fixtures too. This new generation fixture devices different from classical fixtures not only by design but also by its properties.

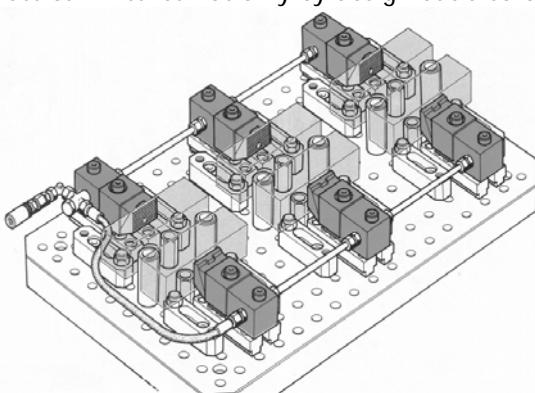


Fig. 1: Hydraulically operated clamping fixture

In standard production are mechanical peripheries (for example fixtures) controlled and monitored by operators. In automated production must these mechanical peripheries work in automated mode too. It means, that they must have not only own driving mechanism (hydraulic, pneumatic, electrical), but must have control and monitoring units too. The examples of hydraulic controlled clamping mechanism is at Fig. 1.

In time of working cycle these devices work automatically, without operator intervention and cooperate with other devices of production system.

During a automated work cycle control and monitoring execute by sensors. The control based on sensors and controlled driving mechanism is base conditions for intelligent clamping fixture realize.

These intelligent clamping fixtures apart from the base functions provide same "intelligent" functions too:

- ❖ control of forces and torques acting to workpiece,
- ❖ monitoring of clamping operations and particular elements of fixture by sensors,
- ❖ other purpose oriented functions as clamping jaw change, or change of industrial robots end effectors

The aims of force and torque controlling are increasing of clamping operations reliability, decrease of workpiece deformation and decrease of workpiece surface damage possibility.

The clamping forces are proportional to pressure in pneumatic or hydraulic cylinder. This means, that we can monitor the clamping forces by monitoring of pressure in the cylinder. For pressure

monitoring are used pressure sensors on base of tenzometers. For exact measure of clamping forces we can use force sensors build in clamping jaws.

The monitoring of clamping operations and particular elements of fixture enable the continuous diagnostic of clamping system. In base of this diagnostics can predict the possible future damages of fixture and we can disposal them before come the dropout in production, or ensue the bigger damage on the fixture system, tools or workpiece.

❖ INTELLIGENT CLAMPING FIXTURE DESIGN

At our department is under realization the intelligent clamping fixture for flexible manufacturing cell. The basic condition to this clamping fixture is fellows:

- ❖ clamped workpiece has dimensions up to 60 mm,
- ❖ this fixture must be operated pneumatically (simply to change the clamping force by pressure),
- ❖ possibility of clamping jigs change,
- ❖ this fixture must give information to control system about:
 - air pressure,
 - position of clamping jigs (open or closed),
 - workpiece occurrence in clamping space,
 - clamping jig occurrence at jig holder,

When we will equip the clamping fixture by sensors, we achieve to capability collaboration between clamping fixture and flexible manufacturing cell.

The moving of clamping jigs holder is solved by pneumatic cylinders. Synchronization of this moving is realized by gears. Position of clamping jigs can be detected by magnetics sensors on side of fixture body. The position of clamping jig holder is detected by two magnetic sensors on side of fixture body.

The CAD model of our intelligent clamping fixture is shown in Fig. 2. These clamping fixtures can be used in a various field of small batch production:

- ❖ clamping for NC, CNC machines,
- ❖ clamping for robotized production,
- ❖ clamping for measure systems,
- ❖ clamping for special automatized operations.

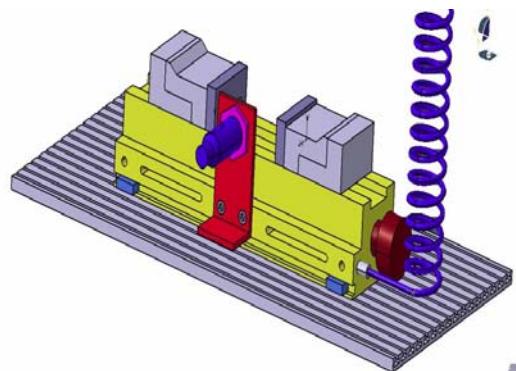


Fig. 2: CAD model of clamping fixture equipped by sensors

❖ CONCLUSION

The cell manufacturing become in last years one of most important manufacturing type. This conception is based on relation between manufacturing cell - workpiece. Flexible manufacturing cells allows manufacturing the small numbers of part from huge range of types and achieve good economical effects near by large batch or mass production. The manufacturing cells structure has connected the machines and save the production time, space and production costs too. Function of machines is coordinated and the material flow can be quick.

Use of intelligent fixtures helps increase reliability of manufacturing operations. Production with intelligent fixtures is more flexible. These fixtures are more expensive and more complex as classical fixtures, because has own automated clamping, positioning, control and monitoring units.

The intelligent devices helps prevent the production disorders in automated production systems.

Application of intelligent fixtures eliminates the hard manual works. Also can save manpowers and increase the productivity.

The aim advantage of intelligent fixture using is their capability reacts to production program exchange. Adaptability of these systems is base of higher generation of automation.

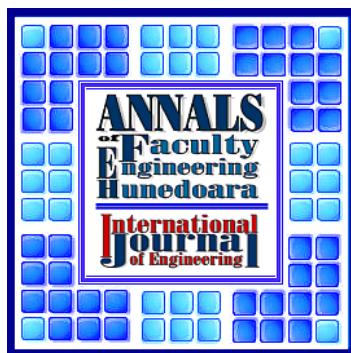
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