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Specifics of assembly activities using bionics

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Abstract: This paper deals with the implementation of bionic principles to manufacturing enterprises. Simultaneously indicating that bionics has a broad scope and innovations inspired by nature have application not only in various technological sectors, but also in management approaches and natural science. The core of the contribution is itself specification of assembly activities and the use of bionics principles in the assembly process.

Keywords: industrial engineering, bionic, assembly, handling.

INTRODUCTION

In engineering production, it is necessary to emphasize some specific features of assembly processes. For example, assembly processes are organized and synchronized in relation to parts whose production is carried out at different times at different production sites and are implemented according to the specified rules that result from the given structure of the products.

Bionics is the application of biological methods and systems found in nature to the study and design of engineering systems and modern technology. Innovations are necessary for success of the manufacturing enterprise and service companies. The extent of their success and implementation of innovations are proportional. The strategic decision of innovation is proved to be crucial for achieving competitiveness. Nowadays, it is necessary to focus on the process innovations which result in the efficient use of human, tangible, intangible and financial resources. Reducing resource consumption is a global issue, it is necessary to find alternative solutions to ensure better solutions providing lower consumption. Implementation of innovative approaches in the design of the assembly processes is desirable, because of rapid development of new customer requirements and organizational changes to achieve cost reductions. It is also developed a range of new technologies (e.g. bionic system), which enable the dynamic development of the new

generation of quality production and assembly systems.

The main bionic benefits are:

- *save energy*: Due to lack of power, nature has tended to extremely organize energy efficient structures, systems and to optimize energy consumption on every step [1, 2],
- *they reduce the material cost*: bionics can help minimize the amount of material used, and thus to decrease the material costs, while maximizing the efficiency of their products to achieve the desired function. Imitation of these natural active strategies can reduce energy consumption in the enterprise. Energy efficiency translates into energy cost reduction and thus to higher profits,
- *define and eliminate "waste"*: organizing material flows in society, the same as in nature; it will be managed by the company's profitability through cost savings. It may be beneficial to the creation of new benefiting centers aimed at the sale of waste to firms with interest in the waste treatment as a raw material [3],
- *strengthen the existing product categories*: Bionics helps to see obsolete products in a radically different light and this new perspective creates opportunities for innovation,
- *define new product categories and industries*: Bionics helps create advanced technologies that will transform the industry, or they can build a whole new industry [4],
- *lead to income*: Bionics can help create a whole new area of business that helps companies grow and restarted / or innovate / obsolete product categories and also attract new customers who are interested in innovation and sustainability, respectively competitiveness [5].
- *Goodwill*: Creation of bionic products and processes, the company can become known as an innovative and also environmentally friendly company.

1 THE FUTURE TRENDS OF MANIPULATION

For example, the company Festo has a technique using superconductors, as well as bionic structure inspired by natural patterns. In these areas is currently ongoing intensive research. Between superconductor and magnet remains stable air gap which can be used for contactless manipulation with objects of without friction losses, or for manipulation with objects in an enclosed area that is separated from superconductors by walls [6, 7].

The successful application of bionics in technical practice is the adaptive gripper *DHDG* inspired by fishtail functions (Fig. 1). They are able to create a surface by grasping surface and are thus suitable for gentle manipulation of objects that can be easily damaged.

Fig. 1. The bionic adaptive gripper [1]

Bionic Handling Assistant (Fig. 2) appears to be a resilient gripper arm whose structure and overall functional principle imitate an elephant's trunk. However, above and beyond its actual benefits, the *Bionic Handling Assistant* is a development platform combining a wide range of technologies and components - from manufacturing concepts to series products like sensors and valves, actuators and grippers, to control technology and software for developing applications and products.

Fig. 2. Bionic Handling Assistant [1]

2 THE FUTURE OF AUTOMATION TECHNOLOGIES

Interesting is the line that the example of blue balls demonstrates various options handle using - for example *Bionic Tripod*, pneumatic muscles (Fig. 3), outside the box by "*grass*" - bionic structure biasing ball forward through each leaf curling "grass" (Fig. 4). *Fluidic Muscle* is a tensile actuator which mimics natural muscular movement. It consists of a contraction system and appropriate connectors. The contraction system is formed by a pressure-tight length of rubber hose, sheathed in high-strength fibres. The fibres create a rhomboidal pattern with a three-dimensional grid structure. When internal pressure is applied, the hose expands in its peripheral direction, thus creating a tensile force and a contraction motion in the muscle's longitudinal direction. For example, a *Fluidic Muscle* with a 20 mm diameter develops as much force as a conventional cylinder with a 63 mm diameter at the same pressure. Both actuators develop a force of 1.5 kN at 6 bar, even though the cylinder has almost ten times the cross-sectional area and about eight times the weight. With the *Bionic Tripod*, *Festo* is adopting a new approach in handling technology as an alternative to the portal systems that are predominant

in mechanical engineering. Sorting, palletizing and fitting: tripods are suitable for a wide variety of three-dimensional handling tasks, especially with small objects. This technology can be used wherever small masses are to be moved rapidly and flexibly [8, 9].

Fig. 3. *Tripod* and *Fluidic Muscle* [1]

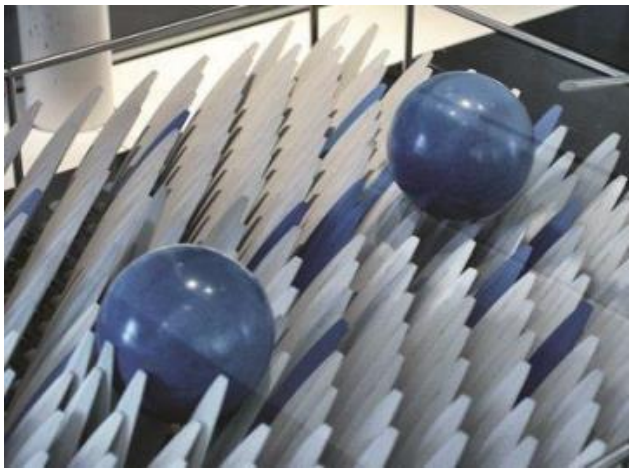

Fig. 4. Bionic structure inspired by grass [1]

3 BIONIC ASSEMBLY SYSTEMS

Bionic Assembly Systems (*BAS*) are able to cover different needs in the exploitation in one better way than classical types of assembly systems, such as flexible assembly systems. The main characteristics of *BAS* are [10-12]:

- the variable structure of system, the number of stations can vary from min 1 of each type to unlimited,
- this system is possible to organize as workers friendly system, which has the possibility to be high, automated from one side and has ability to integrate of workers from other side,
- product mix and size of run can vary in extremely wide range,
- self-organizing behaviour of system make it robust against external and internal disturbances,
- Variable dynamic layout of system can be used for optimization of working scenario and system parameters,
- the *BAS* can very quickly respond on the demands of master scheduling system.

The concept of *Biologic Assembly System* (*BAS*) is logical result of the further development of flexible assembly systems. The *BAS* has stronger characteristics of self-organizing, robustness, and adaptation. The main problem is the conflict between hierarchy and heterarchy. The concept is suitable for application by most complex flexible assembly systems. The concept accepts the variations in the structure of assembly system. Introducing of additional assembly stations without change scheduling strategies and scenarios can increase the capacity of system. This system is possible to organize as workers friendly system, which has the possibility to be high, automated from one side and has ability to integrate workers from other side. This characteristics of system open basically new trend in the development of automation, and that is the (re)integration of workers in high automated industrial environment.

This development can be highly interested for the solving of present situation in development countries which have high rate of unemployed skilled people which cannot be integrated in classical automated systems. Variable layout of system can be used for optimization of working scenario and system parameters.

CONCLUSIONS

Nowadays, robots can perform complex operations and thus replace humans. They are often more reliable, faster, can work longer than a person. The machines they had to help a person at work, now they do the work without people. Machines are constantly replacing more and more people. In the future, machines will not only work for people, but will also be able to repair and manufacture themselves.

Innovations are an integral part of industrial production. Among the main reasons for these innovations are the elimination of existing problems in production, the replacement of outdated means of production, the fulfillment of new legal requirements and many others.

People can always learn from nature. Nature often provides fresh impetus and new approaches to solutions for industrial applications and is the most natural source of inspiration and innovation. This situation is mainly conditioned by insufficient degree of development of materials and technologies. Many ideas from nature cannot therefore be implemented and the extent of mass production or the extent of the prototype.

Research and development of materials and technology will progress and creates space for application of natural principles into technology.

In the future it can be expected that intensive use of natural principles to solve engineering problems.

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