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AUTOMATED PRODUCTION SYSTEM FOR PIPELINES OF VESSELS

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Abstract: *The workplace of the automated production system APS is connected to the 3D CAD system for the preparation of working documentation for pipe systems of vessels. The 3D model of pipe systems is used as a base. The technological background for production is processed from the automated design of 3D models for pipe systems with an output that goes straight into the automated production process. The automated production line includes numerical controlled daily stock of raw material and a computer-controlled workplace for measuring and cutting pipelines.*
Key words: *CAD, production, vessel, industry, automatism*

1. INTRODUCTION

The purpose of this paper is to present the basic principles of automated production system - APS connected to the 3D CAD system for the preparation of a documentation of production for pipelines of vessels.

Work done by human force is expensive and includes the possibility of making mistakes in the working process, known as the human factors. In the ship building industry, it is possible to automate many production processes and thereby increase production intensity and the accuracy and perfection of the products, while decreasing the effect of human factors. A further positive result could be the improvement of the working condition for the people interested in this field.

Pipe systems are one of the most important elements of the vessels that ensure the usability and safety of the ships. What affect the general quality of the ships is the production and the quality of pipe systems. The labour input for the pipe production requires 13-15% of the production time of the complete vessel. Based on the spatial arrangement of pipelines we can say that the automation of the design and production process is a highly complicated and complex problem. The determining question is, however, that how to define correctly the basic principles of the pipeline's routing arrangement. Still, firstly we must define the correct production and montage technology of pipelines. Therefore, it is extremely important to investigate the problem of the automation of the pipeline production process on scientific level.

2. THE DIVISION OF PIPELINES

The most serious problem is the indeterminateness of the pipelines' space arrangement inside the vessels. Pipelines can be divided into groups based on how they are supported by documentation.

- Geometry, forms, dimensions and technology of prefabricated pipelines are exactly given by the production documentation.
- The dimensions and technology of produced pipelines are given only by a schematic documentation arising of the function of the pipe system.

3. THE PRESENT SITUATION IN MANUFACTURING

In the case of the prefabricated pipeline the production technology is based on the prepared documentation that contains all of the needed information for geometry, location and engagement of pipelines. By using this information it is possible to manufacture the prefabricated pipelines in production lines arranged in the optimised technological sequence. The creation of the mentioned production lines increases the efficiency and flexibility of production and decreases production costs.

In the case of the mounted pipelines the production technology is based on the investigation of real conditions of the built vessel. This kind of realisation ensures that the produced pipelines will be accurate and will not need any additional changes or corrections caused by the incorrectness of steel construction or errors in arrangement of equipments. While time consumption grows and efficiency decreases, the production costs increase – which means that this way of production is inefficient especially in the present economical situation.

4. THE POSSIBLE SOLUTION

Compared to the classical hand-made documentation it is possible to shorten the time needed for the development of a new product by 30% approximately.

Rapid technical development in the computer technology and software allows us to create a fully three-dimensional mathematical model of the steel construction for a vessel. This solution gives us the possibility to use the mathematical model of steel construction as a basis for a three-dimensional model of pipe systems. In this case we have to face with a serious problem: while parts of the steel construction are connected in well defined ways - they are welded to each other - parts of the pipe systems are hanging nearly free.

The flexible production system is characterized by different stages of automatisation, while non-production operations by different levels of integration of the subsystems including technological, revision, transport, or manipulation systems. We need to keep our disposal very flexible and adaptable to the system that will respond immediately to the changes in the range of products without the time consuming hand-made set-up of production equipments. Although, we are talking about pipelines in general, we have to make difference between the pipelines because of their difference in length, geometry, dimension and material. The production system that is able to meet all of our requirements is the flexible production system. We can define the the flexible production system as one or more technological equipments with the system for ensuring their function in automatic mode. One important aspect is that the system is able to react to the changes of the product assortment: after the changing the control information the system is able to produce other kinds of products as well.

Based on the above mentioned aspects, we can say that the production, transportation and verification equipments have to be universal and multi-purpose. Only a complex built on this principle is able to satisfy the requirements of the repetitive production with oft-changed product assortment. We can conclude that the flexible production system is an automated production line where the change of the product assortment is done by changing the controlling programs that contain geometrical information necessary for the production of the individual components. If we are talking about the controlling programs we can assume that computers will control the system in full range.

5. THE FLEXIBLE PRODUCTION SYSTEM

The basic elements of our flexible production system are:

1. Fully computerized stock of the raw material
   - It is an automated stock equipped by a computer controlled manipulator connected to the central control server that follows the available amount and assortment of raw material and ensures the ordering of the material based on the production requirements.
2. Computerized numerical controlled cutting machines
   - It is a workplace equipped by an automatic identifying unit, a cache and manipulator for material, and an automatic mechanical slitting saw controlled by a computer connected to the central control server.
3. Computerized numerical controlled welding machine for flange welding
   - It is a workplace equipped by an automatic welding machine with a manipulator for pipelines and flanges. A computer connected to the central control server controls the welding machine.
4. Computerized numerical controlled bending machines
   - It is a workplace equipped by an automatic bending machine with medium frequency heating of the bent material; it is possible to use it for cold bending also. The control program is transmitted from the CAD system for the three-dimensional model of pipe systems.
5. Equipment for inter-operational transport and manipulation with components, products and tools.
6. Equipment for operational transport and manipulation with components, products and tools from the stock to the first workplace and from the last workplace to the stock for the final products.
7. Equipment for verification and measuring
   - It is a workplace equipped by instruments for geometry verification and measuring instruments for the investigation of the real dimensions of products. In the case of non-reparable mistakes in geometry – out of the tolerance limit - the system is able to correct the next product to ensure the correct connection.
8. Equipment for identification and sorting
   - It is a workplace equipped with a bar code generator for the labelling of the final verified products with automatic selection and sorting according to pressure classes.
9. Diagnostic equipment
   - It is a workplace for the verification of pipelines by hydraulic pressure according to the classification rules with a possibility to print out the test protocol.
10. Equipment for coating services and preservation
    - It is a workplace equipped with units for the preservation of the final products and for paint coating or galvanizing.
    - The workplace for zinc coating is not a part of the flexible production system. At this point products leave the system and after coating they return to the next workplace.
11. Computerized stock for final products
    - This is a workplace that ensures acceptance of the final products from the previous workplace and from the workplace for galvanizing.
    - Scanning and monitoring equipment
    - This is a system of industrial cameras connected to the central control server that ensures visual following of failure-free functionality of the production line. Sensors and detectors at the key points for following the transport and production movements and operations complete the system.
12. Control and communication central server
    - This is a computer system equipped with powerful computers that continually in real time evaluate the status of the flexible production system, program steps balance, completion of transport requirements, status of storage and resources, completion status of orders, existence of new orders and status of final product stock. They also generate orders for raw material depending on the stock.

The above described flexible production system can be connected to the CAD system which handles the three-dimensional model of pipe systems of vessels. In this case the control programs are transmitted through the internal local area network. For acceptance of geometries from external CAD systems we need to have a workplace for preparing data for the flexible production system.

6. CONCLUSION

The above described flexible production system is a tool to automate pipeline manufacturing. Provides an efficient method of organizing complicated equipment operations and push the production organization nearer to rapidly limited number of workers. This is realized by automating manufacturing processes; coordinating the automated processes in materials transport and using computers to automate production preparation and production control. While using this technology, the production time decreases so that the production would be efficient. However, system has two disadvantages: there would be a very high investment cost and a complicated control and actuating system. It is necessary to carry out a very thorough analysis of the cost, labour consumption and feasibility of the project. The sketched problem is complex and complicated, as it is not possible to solve it by using only one alternative. On the other hand if we correctly solve all of the controlling, verifying and monitoring processes, we can ensure failure-free functionality of the system. Based on this we can provide a system that can support not only the shipyard but also other external customers by accurate pipelines that meet their requirements.

By using the flexible production system we can dramatically shorten the period for the refund of the investment and ensure production of the highest quality. Based on above very shortly explained research work we can say, that the way for unmanned automated and adaptive production lines controlled by computers is open and is useful for companies producing pipeline components not only for ship industry.

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