Usage of information safety requirements in improving tube bending process

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Abstract. This article is devoted to an improvement of the technological process's analysis with the information security requirements implementation. The aim of this research is analysis of the competition increase in aircraft industry enterprises due to the information technology implementation by the example of the tube bending technological process. The article analyzes tube bending kinds and current technique. In addition, a potential risks analysis in a tube bending technological process is carried out in terms of information security.

1. Introduction
This article is devoted to an improvement of the technological process's analysis with the information security requirements implementation. The aim of this research is analysis of the competition increase in aircraft industry enterprises due to the information technology implementation by the example of the tube bending technological process. The article analyzes tube bending kinds and current techniques. In addition, a potential risks analysis in a tube bending technological process is carried out in terms of information security.

Machine building nowadays is a unified integrated system of a height-tech manufacturing and a modern design technology. Enterprise production processes in this industry are extremely complicated and intense data flows. A significant part is engineer documentation and technological process control data. Implementation of the integrated information system in industrial engineering allows one to optimize and improve production processes, one of which is the tube bending. A need for creation of the turning parts without a fitting quality degradation and an increasing risk of appearing damage areas often arise during pipeline or supporting structure installation. A strength quality of a segment, which is attached to a fitting, will be worse than that of a solid tube. The creation of bend includes a tube processing technique, which is, in industrial conditions, realized by a special machinery – automatic tube benders.

Using the automatic machines with a numerical program control (NC), the tube bending became more exact and less costly. The modern automatic NC-machining technique has a considerable advantage – the bending accuracy up to the tenths of the angle degree.

2. The bending process
The bending process with the NC-machining technique can be realized by several methods [1,2,3]. The most common is using machines, which work by the winding method. Usually this machinery is...
equipped with mandrels. The operation principle of the tube bender that works by the winding method is that the tube, placed on a mandrel of a bender, is locked by a clamp to a bending wheel groove and, rotating around with this clamp, it drags along the tube, winding it on a bending wheel along the bending wheel groove radius till the needed bend angle. Herewith the fulcrum for the tube curve is a fitting of a slip boot, and the mandrel, that is within the tube, prevents the tube from reforming the tube section. The winding lasts until the needed bend angle is reached.

The mandrel is a tooling equipment element, which is, while a translating carriage moves, stays in a bending area and keeps a band safe from the additional inner deformations. Mandrel bending replaced the method of bending the tubes with a filler, where different kinds of materials are used as a filler, for example, lake sand. That is, the mandrel itself and the possibility of its position control are the outline of the mandrel bending. Mandrel bending, unlike all other bending methods, can provide a small radius bending with no patent defects like ovality or corrugations.

A non-mandrel tube bender machine with the NC usually works as a tube rolling system. An object is installed between the two wheels, one of which is rolling and the other is fixed. The rolling wheel moves around the fixed one so that the tube keeps being tighter to it. Due to this, an object takes a given shape, set by the fixed wheel radius. Non-mandrel tube benders are mostly used with a tube with thick walls. Tube benders and pipe-bending machines work with a winding method is most frequently used in tube bending for aircraft and space industries, motorcar construction, and tractor production and in other spheres of machine building. Those pipe-benders enable one to get a qualitative tube bend with a small radius and provide absolute identity of parts geometry during parts production with a spatial bending.

3. The rolling tube bending method

The rolling tube bending method is often applied in building industry. The principle of this rolling method is pressing the tube to the fixed bending wheel groove by a rolling wheel. A rolling and fixed wheel groove of the pipe-bender should match a type and a size of building elements of tube bending. Fixation (locking) of a band in a pipe-bending machine proceeds out of the rolling wheel motion area. This rolling method is usually used for the thick-walled pipes. To attain a given ovality of the value point in a bending spot, the pipe-bender should have a device, which enable one to regulate the gap between the fixed and rolling wheels of a pipe-bender. In cases, there is no need for strict requirements for the ovality quality, shape integrity and spatial settings of the tube components produced, then the pipe-bending machines with a rolling method are mostly used.

The oldest one is an arbalest-bending mode – a simple method when a tube is fixed on both ends with the roll pressure in the middle. This mode disadvantage is a complexity and impossibility to reform precisely to a next bend and the bending quality. The principle of operation consists in loading the bending force through a coupling rod and bending spot to a middle of a tube, laying on a two rotary footage. Bending force on a coupling rod and a bending spot can be caused by a hydraulic, pneumatic, electrical or mechanical energy source. This type of tube-benders is aimed at piece tube bend in constrained terms. However, the tube band quality and a geometrical repeatable accuracy of a detail, by no means, must meet the requirements of industrial production.

The tube and section bending machines use a three-roll bending method – a tube lies on two rolls, and with the help of the third one, the pressing is accomplished. In the process, the tube feeds into aside, which means that it is not one-time but constant pressure on the bending area. This method is applied to big radius bending. The advantage is that there is no need to have special production tooling for the bending radius – in the three-roll bending machine the radius is set by a roll position, and one and the same tool is used to form different radii [1, 2, 3].

An automated or mechanical manufacturing line is the essential attribute of modern machine industry. The machinery with a numerical program control (NC), as well as programmable robots implementation, enables one to increase substantially a productivity, to exclude a probability of human factor influence and to improve product quality. Programmable machinery availability enhances manufacturing efficiency several times and reduces the costs a lot. The crucial part in conversion to
automatic production is played by the information, which determines the processing.

4. Information technologies
Information technologies give great advantages in functioning mechanical engineering enterprises. Usage of modern information technology significantly increases the efficiency of manufacturing processes and reduces information-processing costs, which is necessary in product manufacturing of a mechanical engineering company. With information technologies, it is possible to solve the task of collecting, storage and processing of information about all main features of an item, product testing and its operation through the entire life cycle until utilization.

A great quantity of information on each item permanently complicates the process of its handling. During the designing, technological engineering, product testing and control, more than 120 documents were used: component outline drawings, technical specifications, descriptive memorial, control methods, tests schedule, operations manual and others. All these documents are kept in paper archives and the time to find them is necessary. When working with the NC-machining technique, the amount of paper documents is much smaller, but still it is not possible to get rid of them completely.

If the product is highly technological and science intensive, more active information technologies are used in all process controls. In its turn, using technologies today is an indication of integrality of the manufacturing systems.

5. The principle feature of automatic manufacturing machinery
The principle feature of automatic manufacturing machinery – existence of a command module, which is accountable for the machinery automatics actions. An operating program determines a machine tool actions algorithm. Besides the program itself, machine tool PLC contains information about equipment, materials and operation modes.

At different stages of item processing and production itself, the databases are forming automatic design systems. The first stage is developing of a three-dimensional model and drawings in automatic design systems. Therefore, the files with the data are kept in an internal storage of a system. The next step is to form a control process layout, which is also kept in this internal storage. To develop process layout of the operating program, a postprocessor is used for the NC-machining technique. The operating program that is developed is kept both in internal storage and in machinery data storage.

The transfer of the operating program to PLC machinery can be done by different ways:

- Inputting the operating program to the machinery software.
- With the help of a customized port.
- With the flash-storage device.
- Through the internal network of an organization.

Therefore, keeping in mind close integration of the operating systems with the PLC NC in conditions of modern machine-building industry, it is always a data theft risk at any stage of item processing and during the production itself. Operation systems have software security facilities – identification and authentication system, log and access control books and so on. Manufacturing equipment in a production facility, as a rule, is not equipped with complex information security systems. Production facilities, in which the machinery is based, are supplied as usual only with a video surveillance. It is typical that all workers of the shop have the physical access to the machinery. In addition, in companies, the data transfer process from operating systems to PLC NC and data storages, which are used in these transfers itself, are usually not controlled. In addition, persons, who carry out commissioning work, technical maintenance and equipment repair practically, have an unlimited access to machinery during the works execution, including remote access.

For example, there are some risks of appearance of this situation [6,8]:

- The theft of technological information from the internal storages. The personal workstations often have a unified feature list and they are used to work with both technological information and corporate segment applications. The integration with the corporate network goes through the internal lines and the Internet.
• The information leakage while transferring the operation programs to the PLC of the NC-machining technique. Modern machinery more and more often implies the internal network usage for a man and machine tool interaction. Herewith the process equipment usually does not demand usage of any connections control and management facilities or network activity monitoring. Data capturing is possible while transferring the operation programs from internal storage to machine tool with connection to the technological network.

• The operation program of the NC-machining technique can be copied from the production facilities. It has a minimum set of security means (identification) for the users. With legitimate user grants for the equipment (operator, supervisor, production engineer etc.), a worker has an opportunity to capture, with no hindrance or control, the operating program.

6. The implementation of an IT-security system

Thus, ones captured basic information about process-related parameters; it is possible to reconstruct three-dimensional models and drawings, including assembly drawings. The data, captured from the internal storage of a production engineer station, make it possible to restore operating circuit, equipment and tools information. This way, with unauthorized captured data, a complete technological process can be restored with the materials, tools and technological production performance information included.

The implementation of an IT-security system can improve the security and quality of the technological processes due to IT-security specifications given below:

• Defining the key information dealing with the technological process for the purpose of defend (design documentation, technological flow carts, normative documents for process and quality control and so on).

• Defining the list of persons that have work permission and, which is more important, have a right to change the information dealing with the technological process (design office, manufacturing manager department, quality control department, etc.).

• Differentiation of the information access permissions during the work flow (machine manager, production engineer, mechanics, supervising foreman and so on).

• Integration of different equipment, required in work flow (design documentation stations, NC-machining technique, analytical equipment of the quality control department).

• Defending the information circuit between the subdivisions and equipment.

• Ensuring reliability and faultiness of the information storage devices and information circuits within the enterprise.

To provide data and IT-security and to maintain its life cycle, there is a need for some activities that unite both organization and technical parts. Moreover, these activities should be terminal to keep in correspondence with the IT technology and computer aids evolution. An organization part contains performance specifications, procedures and activities to provide the security of using systems, staff qualification and requirements and so on. The technical part spreads information security tools, consists of special software and hardware-based complexes [4].

The authentication system and its cryptographic subsystem play an important role in documentation protection. Modern technologies afford using both simple and cryptographic security means at the same time [6, 7]. There is a need for not only defending information against its unauthorized copying and dissemination, but also from the unauthorized changes and destruction.

During the tube and the bending technological process, the loss and unauthorized changes risk can arise:

• While transferring the design documentation to manufacturing subdivisions. For the sake of risk minimization, at this stage it is necessary to determine the list of persons that have work access and permit for design documentation changes, and defend information circuits and information storage devices.
• During the technological process planning and technological flow cart making. At this stage, it is necessary to determine the list of persons that have work access and permit for documentation changes, and to defend information circuits and information storage devices.
• During a tube bending process. To minimize the risks at this stage, it is necessary to determine the list of persons who have work access and work flow options changes, to flag the clearance levels of changing the equipment working parameters;
• During the quality control at production stages. At this stage, it is necessary to define the list of persons, having access to check sample and technical documentation, and to distinguish clearance levels to the analytic equipment work process-related settings.

7. Conclusion
Nowadays, the list of potential risks is incomplete and general, but reaches the most part of machine-building industry enterprises. However, based on the analysis of the tube bending workflow given below, one can suppose that it is possible to raise the quality of a final product, to reduce the rejects and costs for the unauthorized interferences in the technological process.

IT-security is the most relevant trend nowadays. Today the activity of any enterprise is concerned with collecting and transferring information. Information is a strategically important source, especially in developing new technologies and products. The loss of the information source or private information, captured by a competitor, as a rule, causes a great damage to enterprise.

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