# CREATING VISUAL WORK INSTRUCTIONS TO ENSURE SAFE AND FLUENT OPERATION OF THE SEMI-AUTOMATIC PRODUCTION LINES

FEDORKO Gabriel[1], MOLNÁR Vieroslav[1], BELUŠKO Matúš[1], HEGEDÜŠ Matúš[1]

[1]*Technical University of Košice, Faculty of Mining, Ecology, Process Controlling and Geotechnology, Kosice, Slovakia, EU*

**Abstract**

Modern production strategic goals all over the world are based on zero defect and safety first. Both are key factors to achieve high goodwill and therefore to gain sales force. Main actor in these strategies is human. Whether is production based on semiautomatic or automatic production lines, human hand cannot be removed completely and so there is a risk of manmade defect. To achieve zero man made defect, it is necessary to standardize work processes and to constantly remind standard procedures. Teaching and reminding of these standard processes can be long and costly. For both, company and laborers, it is important to find fast and safe procedure for working activities in very short term and with minimum cost. Optimal method for this purpose is visual work instruction (VWI). Laborers can learn standard processes from simple VWI placed next to their work place so it is available whenever laborers need to recall them. Such instructions must have standard template so every laborer or group leader can easily use them. VWI can be created also for controlling purpose to maximize zero defect strategy.

**Keywords:** Work instruction, picture-based work instruction, developing flowchart for standard work instruction, standard template for work instructions

## 1. INTRODUCTION

Standardized work processes are already pretty common all over the world but there are different approaches almost in every company. These approaches differ according to type of production or whether it is used for operation standards (created for laborers, production leaders) or managerial standards (administrative workers, managers) [1]. Managerial standards are focused on personnel guidelines, administrative rules and administrative tasks while operational standards demonstrate the best and safest procedure on certain workplace. These standards are implemented not only to ensure quality and safety of production but according to [2] even to measure performance and to visualize the relationship between and errors and its causes. Thanks to these measurements there is an opportunity to provide stable processes and continuous improvements can take place. According to [3] standardized work instructions should include the operation time or sequences of process. Information about the responsibilities that each staff member has and what instruments and documents are used can be added to strengthen quality of production [4]. Standardized process itself doesn´t bring maximum work potential unless standardized work instructions are used. Standardized work instructions have to be established to ensure that work tasks are performed in proper manner and in the right quality level [5]. Work instructions are design to ensure processes consistency and controlling. These instructions should be placed near the laborers work place so they can easily recall old or follow up new instructions. Even operators in the company have benefits from using standard work instruction. Thanks to accelerated learning process monotones are reduced because laborers are able to change working place more often. Laborers can also find imperfection and contribute with improvement ideas that may lead to reward [6]. According to [5] operator should be involved in improvement of standard instructions because they are the experts of the work in certain production lines. If operators are involved in such improvement process they are more likely to follow new work instruction as they will be more satisfied with their work. The satisfaction will arise from fact that they are affecting their own situation [2], [3].

## 2. METHODS

There are several types of work instructions. They can be divided into text based work instructions, picture based, video based or combination. To enhance information flow from work instruction digital technology can be used. Digitalization can even speed up process of work instruction development or speed up its implementation. To speed up instruction development standard template and flowchart for development itself have to be introduced. This article focused on creating such standard template for robotic controlling station. Controlling stations in robotic production lines are placed anywhere between input and output operation. There can be one or several controlling station in robotic production lines. Basically there might be controlling station after every welding or riveting station. To save time of creating work instruction standard flowchart and template is developed. For this purpose part of already developed flowchart (see **Figure 1**) will be use and upgrade to facilitate the needs of work instructions for controlling station.

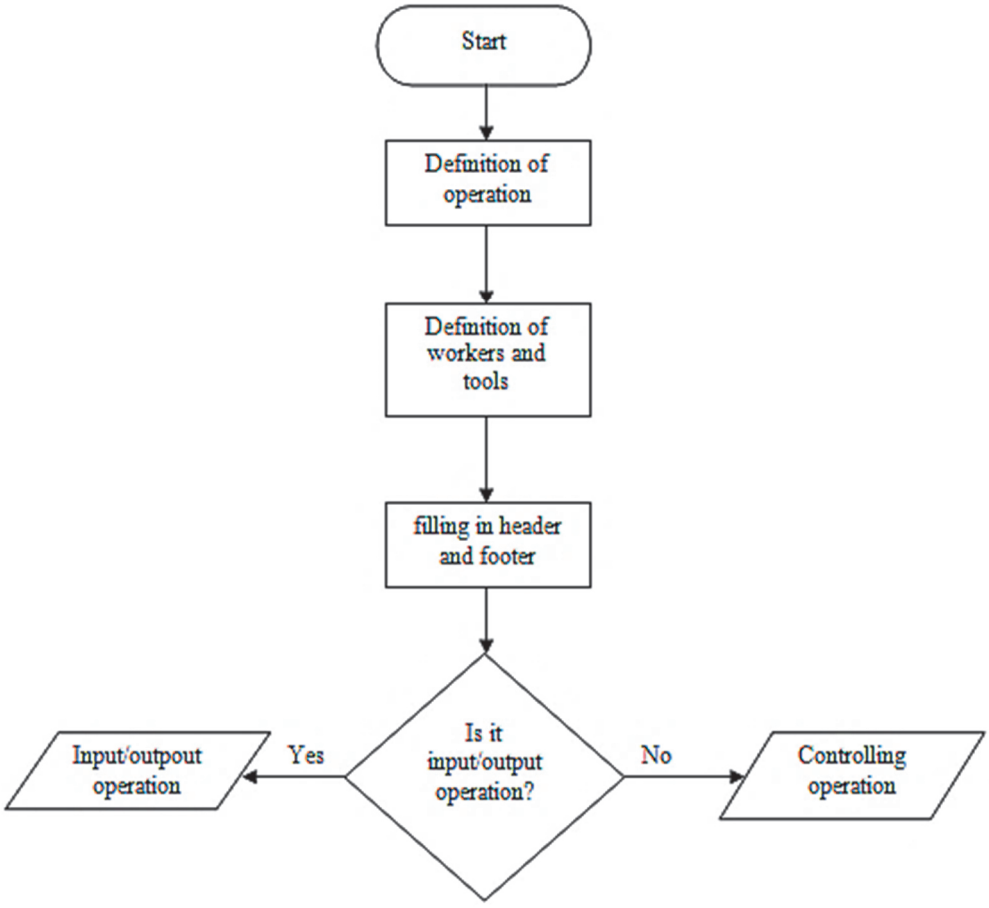


**Figure 1** First part of a flowchart [6]

To prevent laborers overloading by information there is need to divide work instruction for controlling operation to instructions focused on operation tasks and instructions focused on controlling parameters (see **Figure 2**). This division is necessary to emphasize different goals of these two work instructions. Operation tasks instructions have same goals and advantages as input and output work instructions, therefore similar flowchart can be used. Work instructions focused on controlling parameters are based on showing what has to be done by robots and how it should look or act. It should also show every possible defect so laborers can quickly identify which product is good to go and which isn´t.

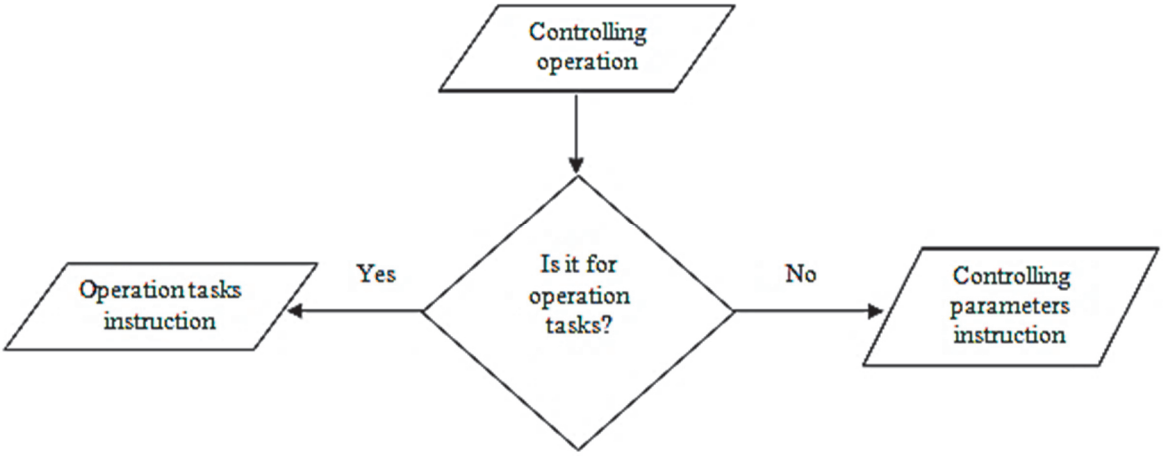


**Figure 2** Second part of a flowchart

### 2.1. First assignments in flowchart

First step in flowchart is definition of operation followed by definition of workers, products and used tools. In "Definition of operation" station number and operation name are defined. In "Definition of workers, products and tools" name of parts, product, name of unnecessary tools, type of worker and number of workers are defined. In last step "Filling in header and footer" information from first two steps are written in header according to **Figure 3**. In the footer are written instruction creator name, date of creation and pagination according to **Figure 4**. After these first assignments we have standard platform for new work instruction whether it is for input, output or controlling operation.

| | | |
|---|---|---|
| Station: CS_1272 | Parts: XY-2125, XY-2126 | Worker: Human |
| Operation: Control | Tools: Wagon-1272 | No.Workers: 1 |

**Figure 3** Developed header of work instructions

| | | |
|---|---|---|
| Created by: Matúš Beluško | Date: 20.02.2017 | Page: 1/1 |

**Figure 4** Developed footer of work instructions

### 2.2. Instructions for operation tasks in controlling station

It is possible to create one work instruction for operation tasks in controlling station if there is same control panel for manipulating with fixture and wagon. Ones work instruction for operation tasks is created it can be used in every controlling station if there isn´t special need for additional information. In this part we created next part of flowchart for this type of work instructions.

#### 2.2.1. Control panel picture assignment

First step is to make real model picture of control panel. In work instructions should be used real pictures of control panels, wagons, fixtures or produced products. Most important part for worker is to learn quickly what several buttons in control panel means. This knowledge is presented by combination of picture and text. Picture of panel is placed according to direction of reading in the region. If direction of reading is from left to right best option is to place picture on left top side because in this area are people most likely to watch at first. Then they are going to read the text. In countries with different direction of reading should be used different placement but with same principle. Control panel picture height should be at least one half of page height or it´s wide

should be at least one half of page wide. Unlike for Input and Output operations scale of control panel and wagon shouldn´t be same size.

### 2.2.2. Explanatory notes assignment

Text in explanatory notes has to be strict and bigger gaps between buttons explanation should be used. Big impacts have font and height of explanatory text. Only simple, sans-serif fonts that are easy to read can be used. No beautification isn´t accepted. Height of text depends on number of explanatory notes but rule that gaps between notes should be as big as text height must be followed.

### 2.2.3. Wagon picture assignment

Wagon itself isn´t main action tool so smaller picture of wagon should be used to prevent unnecessary information overflow. However small picture of wagon had to be place so worker can identify movable object close to him for sake of safety. This picture is placed according to placement of control panel picture. If panel picture is placed in top left corner, wagon picture is placed in bottom right corner and other way around. Scale of this picture should be as big so it can fit the rest of the page.

### 2.2.4. Last assignments

At last arrows connecting concrete buttons with concrete explanation are added together with name of tools. According to ontology arrows are crucial in fast information flow so no exchange of arrows for numbers or signs are allowed (**Figure 5**). Also to ensure continuity of learning process order of button notes have to be same as order of buttons. In case of arrows intersecting other buttons or each other, panel picture replacement or bent arrows have to take place (**Figure 6**). In case of incoherent order of button explanation notes, picture replacement has to take place (**Figure 7**). There is no need to follow up direction of reading rule in this case. Name of control panel is placed underneath picture while name of wagon is placed whether underneath or next to it. One page long work instruction in these type of work instruction should be manageable. Developed flowchart is shown in **Figure 8**.

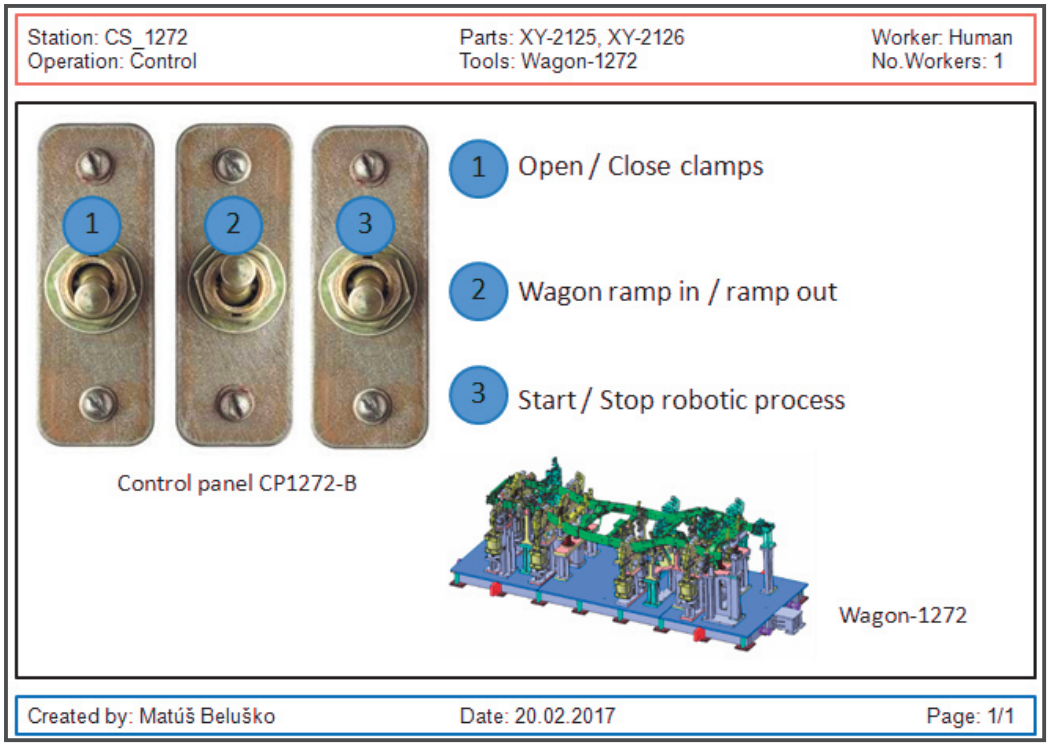


**Figure 5** Work instruction with exchange of arrows for numbers

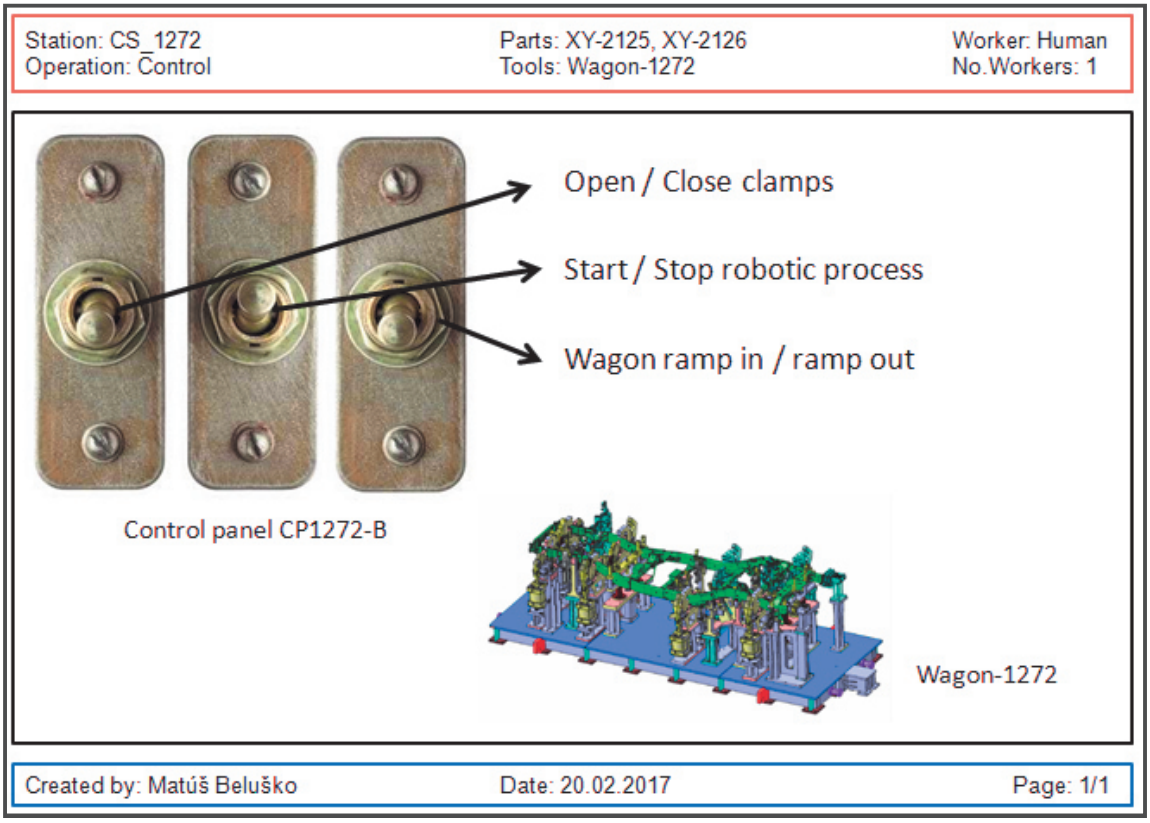


**Figure 6** Work instruction with arrows intersecting other buttons

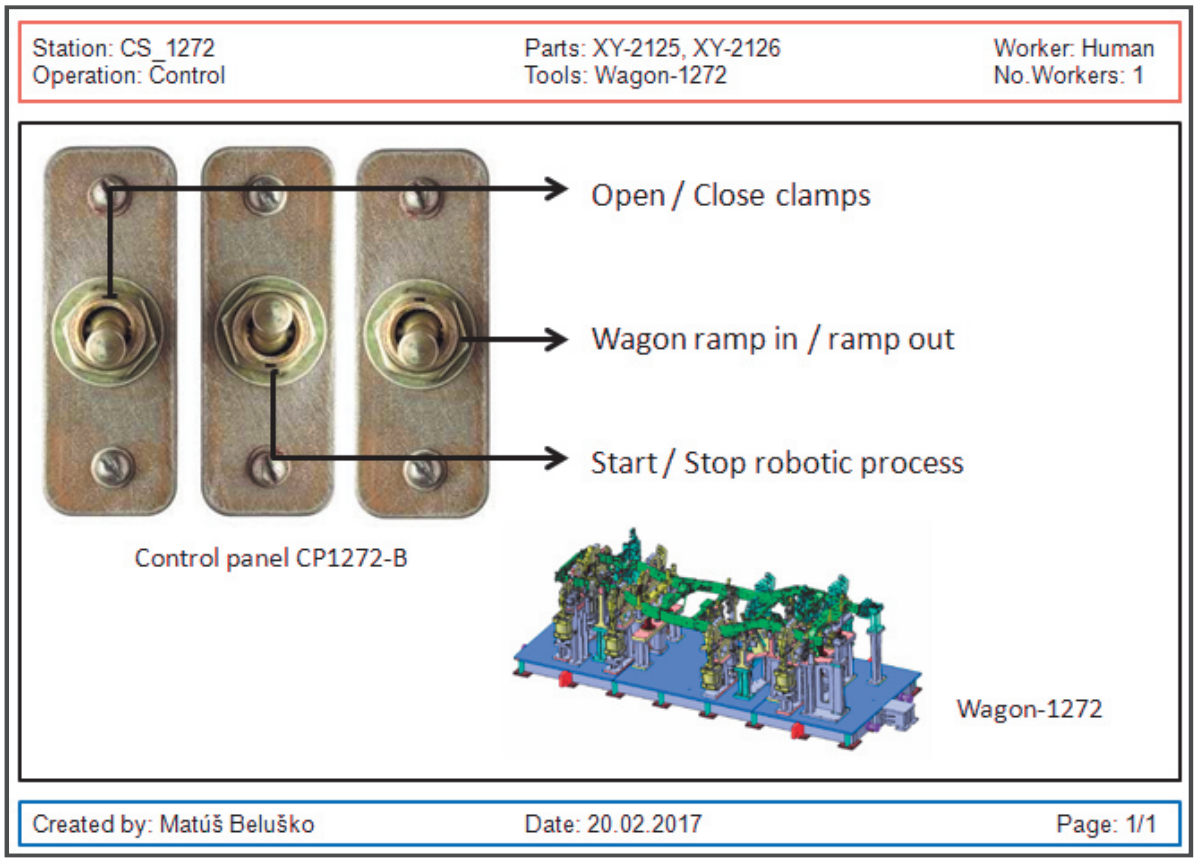


**Figure 7** Work instruction with incoherent order of explanation notes

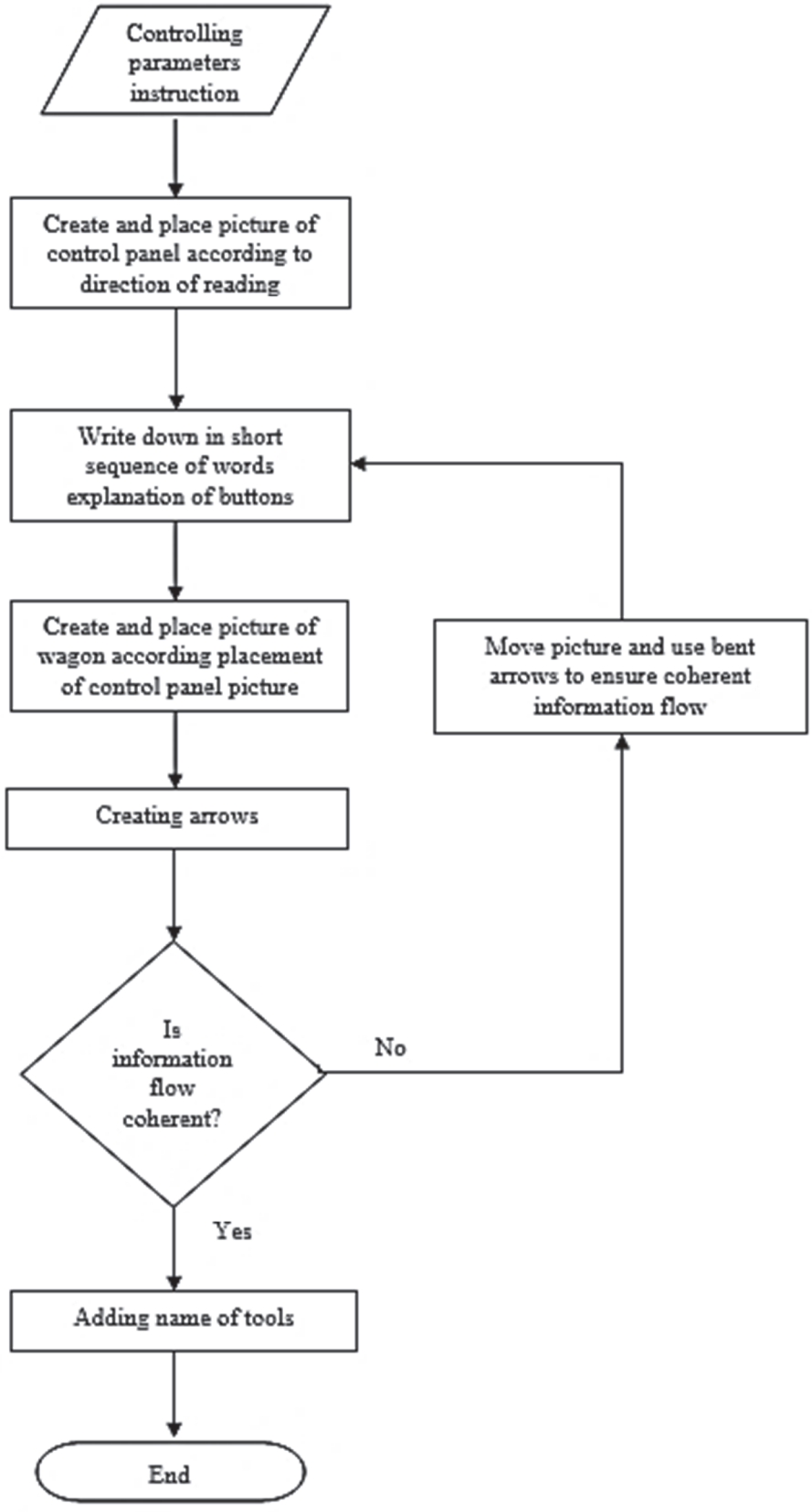


**Figure 8** Final part of developed flowchart

## 3. RESULTS

Based on developed flowchart example of visual work instruction for operation tasks in controlling station was created. **Chyba! Nenalezen zdroj odkazů.** shows final work instruction for simple control panel. In this instruction was defined operation name as “control” that refers to control operation. Numbers of workers and name of moveable tools was set. This information was written down in header and footer. Picture of control panel was created and placed accordingly. Explanation notes were written according to rules written in sections **Chyba! Nenalezen zdroj odkazů.**. Wagon picture was placed and last assignments were created. Last step was to check if the information flow is coherent. Thos control panel is simple and explanation notes were easy to set no additional changes were needed. For next visual work instruction was selected different control panel. All steps were same but in information flow check incoherent flow occurred. To prevent such incoherency additional moves of pictures, arrows and notes had to take place. **Figure 4** is shown final work instruction with control panel that had to be move to prevent arrows overlapping and incoherent explanatory notes. Position of wagon picture was adapted accordingly. Name of wagon moved as well as there wasn´t enough space under the picture.

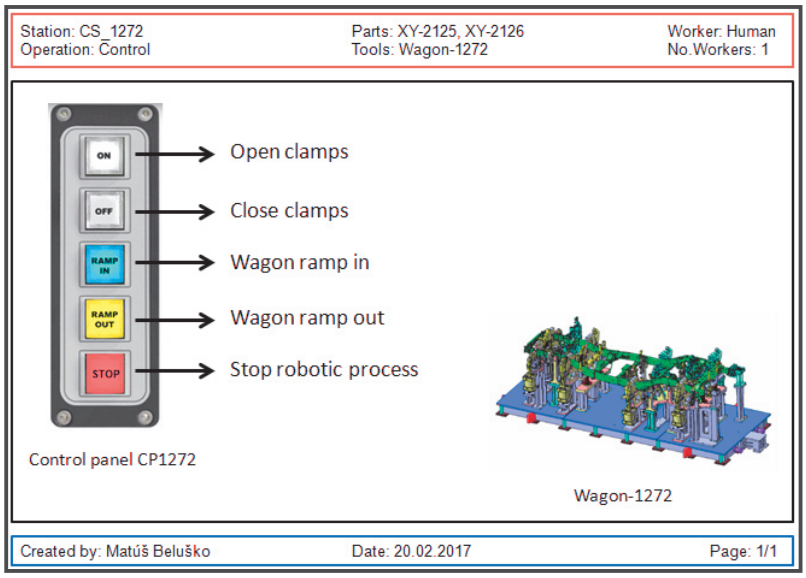


**Figure 3** Final Work instruction

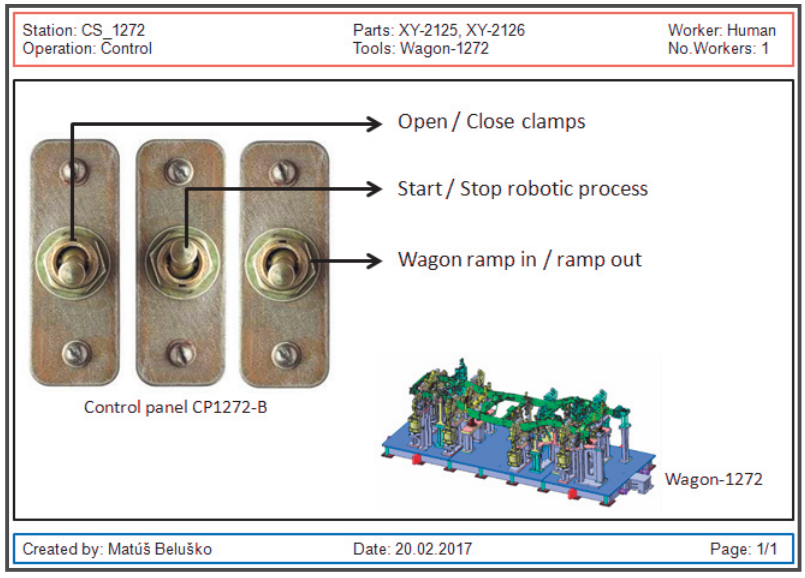


**Figure 4** Final work instruction after additional changes

## 4. CONCLUSION

In this paper approach to create standard template and flowchart for visual work instruction was shown. Base of this approach is developed according findings in previous work **Chyba! Nenalezen zdroj odkazů.**. Developing of standard template for work instruction is crucial to increase productivity, ensure safety and to reach zero defects in production lines. Proposed approach is focused mostly on input, output and control station in robotic cells or robotic production lines.

After standard flowchart was developed several examples of incoherent work instruction ware created in order to show differences and to point out bottlenecks of information flow where speed loss in learning can take place. These bottlenecks were created by ignoring importance of explanation notes order, replacing arrows for signs or numbers and using disarranged arrows. All these bottlenecks disrupt intuitive function of arrows and notes order in visual work instructions. For this type of instructions just one page long instruction is created to prevent information loss. After these examples two final work instructions ware created in order to show right assignment of every instance. By shown assignment in standard template information flow from instruction to worker is speed up and safety is secure. Final work instruction is understandable, easy to remember and fast to produce.

## ACKNOWLEDGEMENTS

***This work is a part of these projects VEGA 1/0258/14, VEGA 1/0063/16, KEGA 006STU-4/2015, KEGA 018TUKE-4/2016.***

## REFERENCES

[1] Imai, M., Gemba kaizen: a commonsense, low-cost approach to management. New York, United States of America: McGraw-Hill, 2007

[2] De Treville, S., Antonakis, J. & Edelson, N. M. (2005) Can Standard Operating Procedures be Motivating? Reconciling Process Variability Issues and Behavioural Outcomes. Total Quality Management , vol. 16, p 231-241

[3] Liker, J. K., The Toyota Way: 14 Management Principles from the World´s Greatest Manufacturer. New York, United States of America: McGraw-Hill, 2004

[4] Boer J., Blaga P., The implementation of new work instructions in the training of human resources in the process of paining in electrostatic field, 2015, p. 514-519, 2212-5671

[5] Ortiz, C. A., Kaizen Assembly:Designing, Constructing and Managing a Lean Assembly Line. Unites States of America: CRC Press Taylor and Francis Group, 2006

[6] Mourgues C., Fisher M., Kunz J., Method to produce field instructions from product and process model for cast-in-place concrete operations, CIFE working paper, Stanford University, Stanford, 2008

[7] Beluško, M., Hegedüš, M., Fedorko, G., Creating Visual Work Instructions to Ensure Safe and Fluent Operation of the Semi-automatic Production Lines. Open Engineering, 2016, p.691-699