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PROPOSAL 3D ASSEMBLY PROCESS OF ELEVATED PLATFORMS

NÁVRH 3D MONTÁŽNÍHO POSTUPU ZDVIHACÍCH PLOŠIN

Abstract

The contribution is dealing with semi-automatic assembly process of elevated platforms. At the beginning of the work dealing with general problems of assembly then focusing on specific assembly. It is also an analysis of the current assembly process. Based on the current process was developed a new proposal assembly. The last step is carried out technical - economic evaluation. That contribution is based on form a completed assembly at company Pars Komponenty s.r.o.

Abstrakt

Příspěvek se zabývá návrhem montážního postupu poloautomatické zdvihací plošiny. V úvodu se práce zabývá obecnou problematikou montáže, dále pak zaměřením se na konkrétní montáž. Dále je proveden rozbor stávajícího postupu montáže. Na základě současného postupu byl vypracován nový návrh montáže. Jako poslední krok se provedlo technicko – ekonomické zhodnocení. Tento článek vychází Z realizované montáže ve společnosti Pars Komponenty s.r.o.

1 INTRODUCTION

The manufacturing process often ends with assembly, during which decisive conditions concerning reliability and quality of a product are completed. Practically all engineering devices consist of individual components. a characteristic feature of assembly processes is connecting two or more components to assembly subgroups, groups and higher units. Technologies that are used to connect these components are usually ones that provide direct connections without additional parts or materials. Beyond connecting assembly usually consists of other activities, like inspecting, washing, breaking in, conservation, transport to assembly workplace and others.

Assembly can be characterized as a set of activities performed by people, devices and machines, with a final product made from individual parts and assembly groups by performing of these activities in certain order during certain time. Assembly is usually the final phase of manufacturing process within engineering industry.

The significance of assembly in the engineering industry comes from the share of assembly in engineering product work expenditure that, on the average, makes 30 to 40 % and also about 30 to 50 % of total number of manufacturing workers is engaged by assembly. In large series manufacture the assembly work expenditure goes down, mainly due to more sophisticated design and higher level of mechanization and automation of the manufacturing process.

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Assembly quality requirements are equal to the requirements of assembled equipment. Poor quality assembly can degrade quality and accurately made components. On the contrary quality assembly can appreciate the manufacturing technology of parts, and simple technological interventions can eliminate possible errors occurring during the part manufacture.

For these reasons we need to actively pursue the questions of assembly processes and search for possibilities how to decrease the costs related to it, for example by suitable construction design and its division to individual assembly groups and subgroups, by selection of simpler connecting methods, by selection of fittings that do not need exact mating, by employing design elements with a certain degree of freedom, by using standardized and unified elements and by other methods.

The basic elements of assembly process are:

- **Part** – an element impossible to disassemble (initial assembly element), a product part that is usually made from one piece of material;
- **Unit** – a unit created by joining two or more parts, while the way how they are joined does not matter; it is a primary assembly element;
- **Subgroup (Subsystem)** – represent a unit created by joining two or more parts without regard to the way of joining; subgroups can be divided to a number of orders, e.g., subgroups of the 1st order can be directly assembled to groups, subgroups of the 2nd order can be assembled to the 1st order subgroups and so on;
- **Group (System)** – the highest assembly element that is created by joining one or more subgroups and other parts;
- **Product** – mostly it is the final tangible assembly product intended for a market that is functionally and constructively finished; it is created from parts, subgroups and groups joined by demountable or non-demountable way;
- **Piece of Equipment** – this is a system of industrial products that should perform given operational and technological tasks.

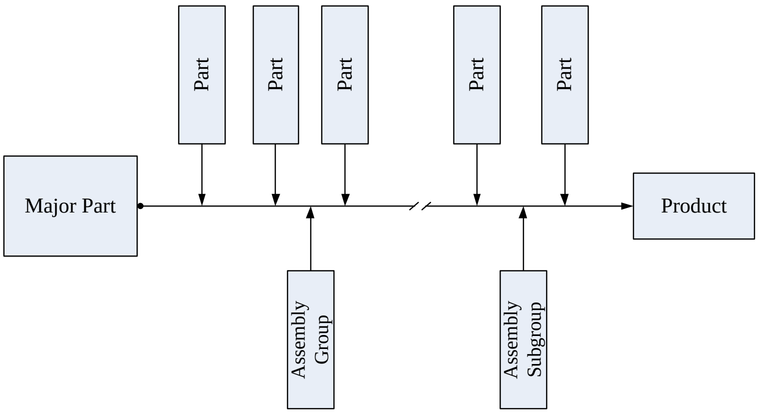

Fig. 1 A simple technological assembly schema. [3]

In case of more complicated parts a technological assembly schematic is created that illustrates the order of assembly of individual parts to subgroups and groups and then to the final product or piece of equipment.

Figure 1 shows a simple technological assembly schematic consisting of the main axis with a basic part on its beginning and a finished product at its end.

Assembly Schematic is the initial document for assembly technological procedure. The assembly schematic gives you an overview of mutual part connections. Further the assembly schematic should show what parts and in what order should be connected together and placement of parts for the correct organization of assembly.

Accuracy of manufacturing has a large share of labor expenditure during assembly goes to adjustment work. Its limitation, or ideally complete exclusion, depends on the production quality and accuracy of assembled parts. Under accuracy we need to imagine dimension and shape tolerances and positions of planes. Just the selection of accuracy is a serious problem for each designer.

For assembly with complete exchangeability parts are made with very narrow tolerances in order to be able to exchange them at will during assembly. Manufacture of such parts is comparatively costly, since special and exact tools, jigs and measuring devices are used for their manufacture.

Production demands for accuracy differ according to a product and production types. The dimensional tolerance is a difference between upper and lower limit dimensions. The figure shows the dependency between production and total costs on proposed sizes of dimensional tolerances.

The figure 2 presents apparent hyperbolic increase in production costs for parts when their dimension tolerances decrease and progressive increase in assembly costs during the increase of the tolerances. The position of the minimum of total cost curve (cumulative curve) depends on the shape of both partial curves, namely the production cost and assembly cost ones. The minimum on the cumulative curve determines the size of optimal tolerance or so called economical one.

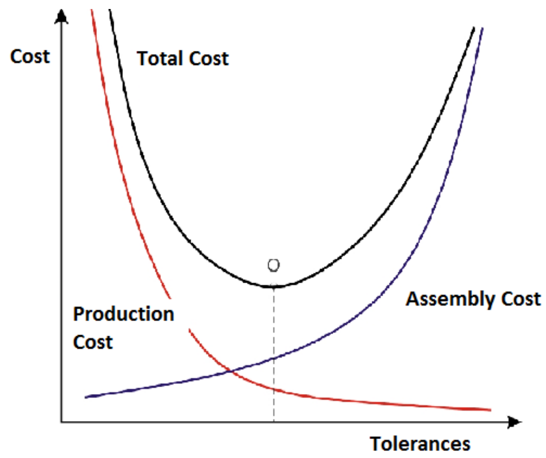

Fig. 2 Graf of production costs for parts for variable dimension tolerances. [3]

2 PROPOSAL OF SEMIAUTOMATIC ELEVATED PLATFORM

Elevated platforms are a special category of products designed for loading and unloading disabled passengers. They have to meet the highest requirements for safety towards the transported persons. They are equipped with a microprocessor control system that ensures continuity and safety of operation, as well as with a number of individual security elements. These lifts are subject to strict requirements of the law and standards.

Semi-automatic lifts for loading and unloading of disabled persons in wheelchairs into passenger railway cars with a floor level of 1250 mm above the rail surface and in stations with platform height min. 300 mm above the rail surface with the assistance of staff. The lift is only intended for fixed installation and is used in vehicles with a design speed of up to 160 km/h.

The main parts of the semi-automatic lifting platform consist of a supporting driven box, a supporting pole, a movable support and a tilting platform. The supporting pole is attached to the vehicle sidewall with a bracket in the upper part and, at the bottom, by a foot of the pole to the floor of the railway car. Unlocking and securing of the pole is done by a locking lever of the pole. The driven box is pivotally mounted to the supporting pole arm.

The box is unlocked and secured by the locking lever of the box. To the box, a movable support is attached by a ball screw, a ball nut and a guide rod, to which the tilt platform is attached. It consists of a fixed part with a tilt handle and of two hinged parts with tilt ramps. The ramps in the tilt position prevent the wheelchair users from going down from the platform. The surface of the lifts and ramps is made from aluminium sheet with a non-slip finish.

In the transport position, the lift is locked by a locking mechanism, which is secured and released by a latch handled by a square key.

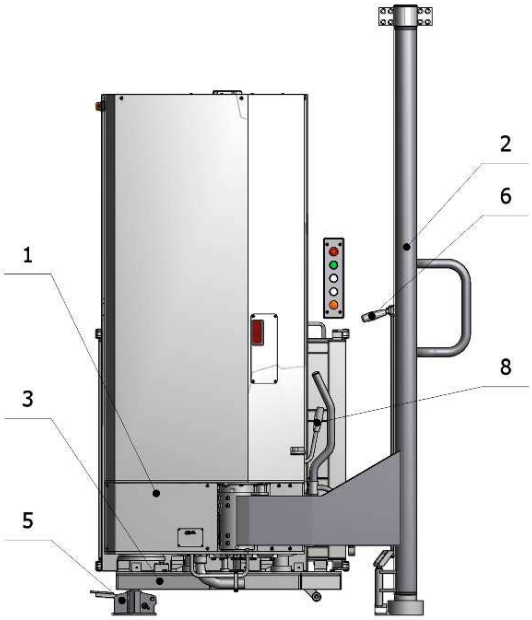

Fig. 3 A semiautomatic elevated platforms.

3 ANALYSIS OF ASSEMBLY PROCESS

The current semi-automatic process of the lifting platform is divided into five main groups and one additional group.

Main groups:

- Supporting pole;
- Driven box;
- Platform;
- Support;
- Lifting platform.

Additional group:

- Emergency drive crank.

The groups are listed in individual technological dispatch notes, which contain piece lists of parts entering into an assembly. They contain furthermore a description of the individual operations with preparatory and unit times.

Currently, there is no detailed assembly process created, because there are two workers assembling the platforms, who have carried out this activity repeatedly for several years. During this time, they have learned to understand the technical documentation available and knowhow and in what order the units are to be assembled.

With regard to deficiencies in the current assembly process I would mention that it does not contain a detailed installation procedure, which increases the demands on the expertise of the employees. Furthermore, a given package of minutes is assigned to the assembly groups, which is not divided into particular operations thus creating a lack of clarity in terms of standardization work.

4 PROPOSAL FOR A NEW ASSEMBLY PROCESS

In designing the new assembly procedure there were elements of lean manufacturing firstly introduced, in particular the 5S method, with the objective to increase order, cleanliness, and orientation in the workplace.

The result of the implementation and compliance with the individual phases of this method is to obtain a transparent, orderly, clean and disciplined work place. Some sources even state a further step of this method, namely the safety of the workplace. Other sources consider this step as unnecessary, arguing that the proper performance of all five S would lead ultimately to a safe working environment. By removing unused items and tools, the elimination of movements and actions will be affected which do not add any value to the product, and thus leading to time saving.

1S: Sorting
2S: Set in order
3S: Shining
4S: Standardizing
5S: Sustaining

Two new groups were added to the main assembly groups of semi-automatic lifting platforms, namely sub-assembly of the rear cover and the sub-assembly of the front cover. With the current assembly process, these two sub-assemblies are parts of the last group regarded as the lifting platform.

Main groups:

- Supporting pole;
- Platform;
- Driven box;
- Support;
- Sub-assembly of the rear cover;
- Sub-assembly of the front cover;
- Lifting platform;

Additional group:

- Emergency drive crank.

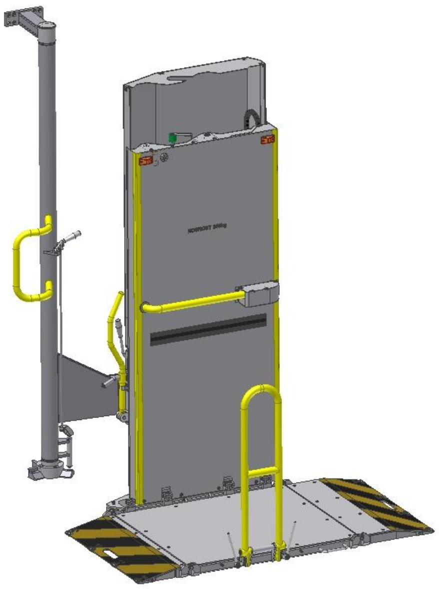

Fig. 4 3D vizualization of elevated platforms.

For a new assembly process has been creating new drawings in Autodesk Inventor Professional, and new assembly procedure with parts lists.

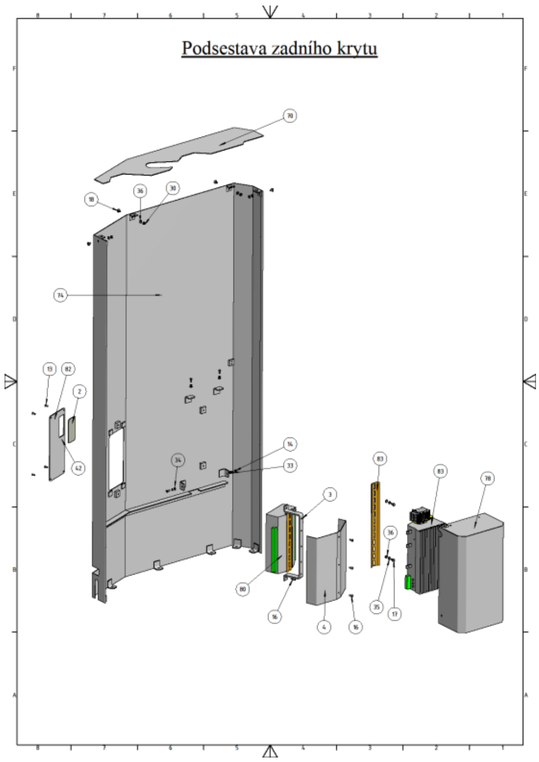

Fig. 5 Drawing sub-assembly of the rear cover.

The Autodesk Inventor Professional 2010 software was used for designing a new assembly process, whereby detailed assembly procedures for the individual main groups and one side group were elaborated. The main objective of assembly procedures created in this way is to make the assembly work more comprehensive and to require less expertise when integrating new employees.

Autodesk Inventor application is the basis of the Autodesk company's solution for the creation of digital prototypes. The Inventor model is an accurate 3D digital prototype on which you can verify the form, shape and function of the design. The need to work with physical prototypes when designing is thus reduced to a minimum. With the ability to use a digital prototype for designing, visualizing, and simulating your products in the digital domain, the Inventor application will help you communicate more effectively, reduce errors and deliver more innovative product designs more quickly.

5 PROPOSAL STANDARDS OF THE TIME CONSUMPTION

When designing new standards of consumption time at the semi-automatic lifting platform the image method was used work operations, which is a direct method of measuring the real time consumption during recurrent work operations and their parts. From the measured values are evaluated duration of individual component parts and the whole operation per processing unit.

Through the the image work operations are derived materials to improve work organization, work process, reducing the time consumption of the element and the whole operation. The acquired data are the basis for the direct determination of time standards for the creation and operation normative. When setting new standards of consumption time was used one of two types of image operations, and continuous measurement

Example of calculation of time-saving supporting pole:

$$U = t_{ASM} - t_{ANM}$$

$$U = 315 - 83.49$$

$$U = 231.51 \min$$

where:

t_{ASM} - the current assembly unit time [min],

t_{ANM} - the new assembly unit time [min],

U - savings unit time [min].

$$PT = \frac{t_{ANM}}{t_{ASM}} \cdot 100$$

$$PT = \frac{83.49}{315} \cdot 100$$

$$PT = 26.5 \ \%$$

where:

PT - compared to the current time standards and new assembly [%].

Saving time at the standard unit supporting pole assembly is reduced to 26.5 % from 100 % of the current assembly.

Tab. 1 Comparison of time standards

Type of assembly	Unit time [min]
The current assembly	315
New assembly	83.49

6 CONCLUSIONS

The main objective was to design a 3D assembly process of elevated platforms, create a new digital assembly process using engineering software Autodesk Inventor Professional 2010 and of assembly operations to set a time standard.

The biggest change and contribution to the lifting platform assembly is a detailed 3D analysis of all parts, which leads to better orientation during assembly and reduces the requirements skilled workers. In designing the new assembly procedure was first introduced elements of lean manufacturing, 5S method specifically, to increase the order, cleanliness, better orientation in the workplace.

Finally my thesis I would like to thank the design and technological department of the company Pars Components Ltd., especially MSc. Vyškovský.

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