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# Improving competitiveness of an assembly line by simulation based productivity increase – A case study

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## Abstract

As a result of constant competitive pressure, companies are forced to constantly look for ways to produce more efficiently. To increase production efficiency and competitiveness, the actual situation needs to be analyzed and measures proposed. However, proposals, when put into practice, do not always result in improvements, due to various errors and omissions in their design. A helpful tool to minimize failures is to apply computer simulations, in which the proposed solutions are being tested and a proven solution implemented into practice afterwards. This is especially important when a proposed solution requires increased investment costs and time. This paper deals with streamlining technological processes on an assembly line of a turbocharger with an electrically controlled actuator, by automating a section of the assembly line (reduced number of operators and defective products), based on analysis and identified deficiencies. The Tecnomatix Plant Simulation software was chosen to analyze the assembly line's condition, as well as to simulate proposed measures' impact on the line's improvement. The design brings increased efficiency of a turbocharger assembly process and a reduced number of workers. According to the simulation results, when proposed improvements are applied, the annual production of the assembly line increases from 89,575 pieces to 98,139 pieces, which is 8,564 pieces more, i.e., an increase of 9.56%, while reducing the number of workers from four to three.

***Keywords:*** *simulation, assembly, assembly line, software, Tecnomatix Plant Simulation*

**JEL Classification**: O33, L23, L62

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## 1 INTRODUCTION

Competitiveness is a basic condition for a business to be successful in markets. This is due to the market situation, which can be defined as highly competitive, globalized, with rising prices of raw materials and resources, the shortening of a product's life cycle, etc. Such factors make competitiveness increasingly difficult to achieve and maintaining it more challenging. Businesses are forced to constantly look for reserves and optimize processes that create added value for the customer. In a search for reserves and bottlenecks, simulations are an especially useful tool. They allow analyzing the existing state and proposing changes, followed by analyzing the impact of changes on the process at low costs for the company. By the possibility of a quick analysis of proposed improvements' impacts on the process, with no negative effects on the real process, an almost countless number of variants can be simulated until a solution with the greatest benefit for increasing a company's competitiveness is found. This article provides a description of simulation implementation in assessing the proposed measures' impact on assembly line productivity.

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## 2 THEORETICAL BACKGROUND

In manufacturing companies, one of the main processes in which value is being created for the customer is the production process. With any product consisting of several parts, assembly is part of the production process.

The assembly process is the final stage of most engineering products. However, its automation and digitization lag other production processes. The reasons are the difficulty of the process, in terms of implementation of automated machines and equipment, along with high financial demands. At present, despite advanced technologies, assembly processes feature the highest use of human labor. For this reason, the efficiency and productivity of assembly lines in the manufacturing sector is crucial (Yasir et al., 2019). In connection with a requirement to increase companies' competitiveness, with an emphasis on automation and digitization processes within Industry 4.0, attention needs to be paid to an analysis of the impact on human resources (Otoiu et al., 2022).

Nowadays, simulation models are being used to assess various aspects of production systems (Mirzapourrezaei et al., 2011). Several authors (Baskaran et al., 2019; Schindlerova et al., 2023) offer simulation models of "digital twins" of a platform for testing and designing variations of solutions and scenarios by the dynamic simulation method, to verify the analyzed line and possibility of the line's variant setting, according to the company needs and response to customer requests. Mozolova et al. (2023) and Klos and Patalas-Maliszewska (2019) deal with making assembly lines more efficient through computer simulations, and emphasize the simulation method's importance in optimizing assembly processes and increasing their efficiency. The recent issue has been attracting more scientific interest. Thanks to the existing simulation software, many researchers have been dealing in detail with the issue of increasing competitiveness and the productivity of existing and newly proposed assembly lines, using the balancing method without a need to verify in real assembly conditions (Çimen et al., 2022; Yasir & Mohamed, 2018; Sime et al., 2019). Adham et al. (2013) used their simulation model as a support tool for assembly line balancing.

Cortés et al. (2010) used a simulation model created in the ARENA application to balance an assembly line in a motorcycle manufacturing company. Bongomin et al. (2020a) used the same line balancing technique. The achieved results showed that an average line throughput increased by up to 55% for globally optimal line balancing. As a result, the cycle time was reduced by up to 36%. Bon and Shahrin (2016) also used the ARENA software and reduced the number of workstation operations and improved the productivity of a motorcycle assembly line. The ARENA application was also used by Neungmatcha and Boonmee (2021) to analyze results of current working conditions, which were being compared with various proposed alternative strategies. The authors proved that the proposed improvements help increase productivity of the motorcycle headlight production line (production cycle time reduced by 25.51%, and production capacity increased by 28.36%, compared to the actual situation), and include a more efficient use of labor (labor use increased by 13.33% compared to the actual situation). The ARENA application was also used by Salam and Liu (2022) for simulating assembly line balancing using heuristics, thus managing to reduce the number of workplaces and workers from 7 to 3. Krenczyk et al. (2018) also used the heuristic approach to design their own IT solution for balancing assembly lines in combination with combined data-driven automatic simulation model generation, while for the practical implementation of the proposed solution, they used the FlexSim software. Pei and Cha (2015) used eM-Plant software to optimize assembly line balance. Jamil and Razali (2016) applied the ProModel software to balance an assembly line for automotive components production.

Islam et al. (2019) tested the improvement of a current sewing line by line balancing technique using Tecnomatix simulation software. Russkikh and Kapulin (2020), Blaga et al. (2017), Sujová et al. (2018), and Larasari et al. (2020) also used the same software for efficient use of production capacities. Afifi et al. (2016) researched a system's reliability by modeling various problems found within the assembly line (such as double handling), and then designed and implemented real-world assembly improvements. (Villarreal & Del Roble Alanís, 2011) used a two-level simulation model that simulates plant-level operations (assessing the synchronization of material flows between warehouses and assembly lines) and assembly-line-level operations. The witness software was used by Mirzapourrezaei et al. (2011) to increase the productivity and efficiency of an assembly line for a three-step-production of a starter. First, they identified deficiencies and causes of problems, then identified and verified the model results, and finally refined the model structure. Amarnath et al. (2019) used a discrete simulation model to identify problems arising during assembly, so as to increase overall efficiency and productivity of an assembly line. A simulation model of a garment sewing assembly line created by Yemane et al. (2020) increased the assembly line's utilization to 0.69, with a line efficiency of 58.42% and no additional costs. A similar approach was implemented by Bongomin et al. (2020b), who achieved a 28.63% line production capacity increase through a simulation model of a trouser production line with 72 operations. Hu et al. (2016) modeled and optimized a LED bulb assembly line. Alsaadi (2022), with his discrete simulation model, increased assembly line productivity and reduced costs by eliminating less-used assembly line resources. The implemented simulations contributed to an increased performance of all production line processes and overall market competitiveness. Islamoglu et al. (2014) researched the work productivity of two assembly line concepts in a modular production environment. The performance measure was the labor productivity rates of these assembly line concepts obtained from calculations and simulation. Ozdemir et al. (2021) used Tecnomatix Jack ergonomic simulation software for assembly line balancing with an ergonomic risks consideration. Kovbasiuk et al. (2022) used Tecnomatix plant simulation to design an automated assembly workplace and verify its benefits for the production process. Václav et al. (2018) used Tecnomatix plant simulate and Tecnomatix process simulate for assembly line planning in the automotive industry. Trojan et al. (2020) used Siemens process simulate to verify the impact of innovation on a production line to increase its productivity. Caputo et al. (2019) used the same software for the ergonomic evaluation of a manual workstation in its preliminary design phase.

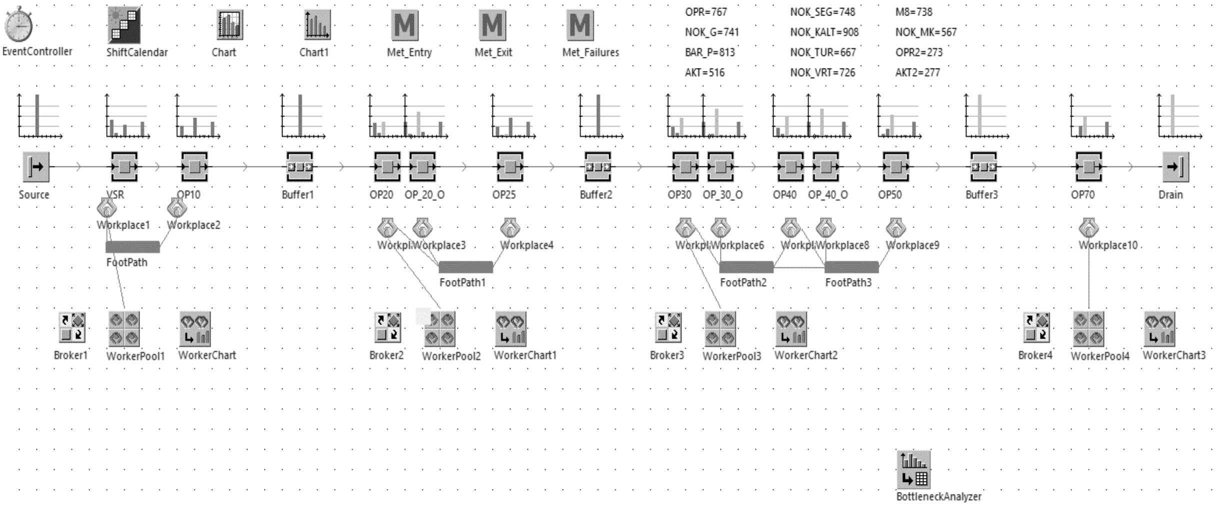
One of main challenges and goals of optimizing assembly lines through various simulation models, within Industry 4.0, is to increase a company's competitiveness. Lettori et al. (2022) also used Siemens process simulate software to assess a prototype assembly line composed of automated logistics systems, cobots, and task guidance systems, thus providing a framework to guide the evaluation of simulation software in the context of Industry 4.0 assembly lines. Assembly processes with a high proportion of manual work, mainly in the automotive industry, are an area where the aforementioned technologies find application and provide scope for reducing product errors, eliminating production line downtime, optimizing production cycles, streamlining assembly activities, with a significant impact on increasing market competitiveness, especially in today's turbulent and ever changing business environment. Kubickova et al. (2021) concludes that Industry 4.0 brings great opportunities for companies, which can mean greater efficiency and competitiveness. In the context of Industry 4.0, the concept of a digital twin is often being used, referring to a creation of a real object's digital model (workplace, line, section, etc.) and fully corresponding with a real state, thus allowing simulation of various changes and their impact on production, while not negatively affecting real production, as stated by, e.g., Yildiz et al. (2021), Sujová et al. (2019), and Židek et al.

(2020). A digital model created this way enables simulation of all aspects of production, including layout optimization in order to improve production (Sadar et al., 2022).

## 3 RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The subject of analysis and improvement proposal is a production line in a company that produces automotive components - various models of turbochargers for the entire range of car manufacturers. Turbochargers are being assembled on several assembly lines, with a different type of turbocharger being assembled on each line. The analysis of individual lines revealed an occurrence of many internal errors in the assembly process. These errors require extra work to eliminate, which increases assembly time and costs. Some errors result in irreparable damage to the product, thus further increasing costs and time. To eliminate these problems, a specific assembly line for a turbocharger with an electrically controlled actuator was chosen as a pilot project. The goal is to make the technological process on the assembly line more efficient by automating a selected section of the line (reducing the number of operators and limiting the occurrence of defective products), based on analysis and identified deficiencies. This should result in the increased effectiveness of the turbocharger assembly process, by shortening the production cycle time and reducing the number of operators.

Based on actual conditions, a model of a turbocharger assembly line was created in the Tecnomatix plant simulation program (Fig. 1). In it, individual workplaces, their service by workers and errors arising at individual workplaces, were modeled. Work on the line takes place in three 8-hour work shifts. There is a half-hour meal break during the work shift.



OPR=767
NOK_G=741
BAR_P=813
AKT=516
NOK_SEG=748
NOK_KALT=908
NOK_TUR=667
NOK_VRT=726
M8=738
NOK_MK=567
OPR2=273
AKT2=277

Fig. 1 – Simulation model of a turbocharger assembly line. Source: own research

Since the goal is to make the line more effective and thus achieve higher productivity, a cause and effect analysis was performed, as shown in Fig. 2. The analysis shows the productivity being affected by errors in handling and component transportation, which is performed manually by workers.

The application of simulation models for the analysis and testing of modern designs of assembly workplaces, when implemented correctly, is a highly effective tool to achieve improvements both in productivity and quality and, in case of manual assembly operations, also in reducing workload and increasing productivity.

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The subject of assembly is a turbocharger (Fig. 3), with an electrically controlled tilting system. The turbocharger serves to increase efficiency of the pressure flow in the turbine casing. The tilting system is controlled electronically, using an actuator with instructions from the vehicle's control unit that uses a servomotor. The servomotor controls the turbocharger’s tilting system through a connecting rod. The turbocharger’s dimensions are 190.5 x 157.5 x 152.3 mm. Its total weight is 9.75 kg.

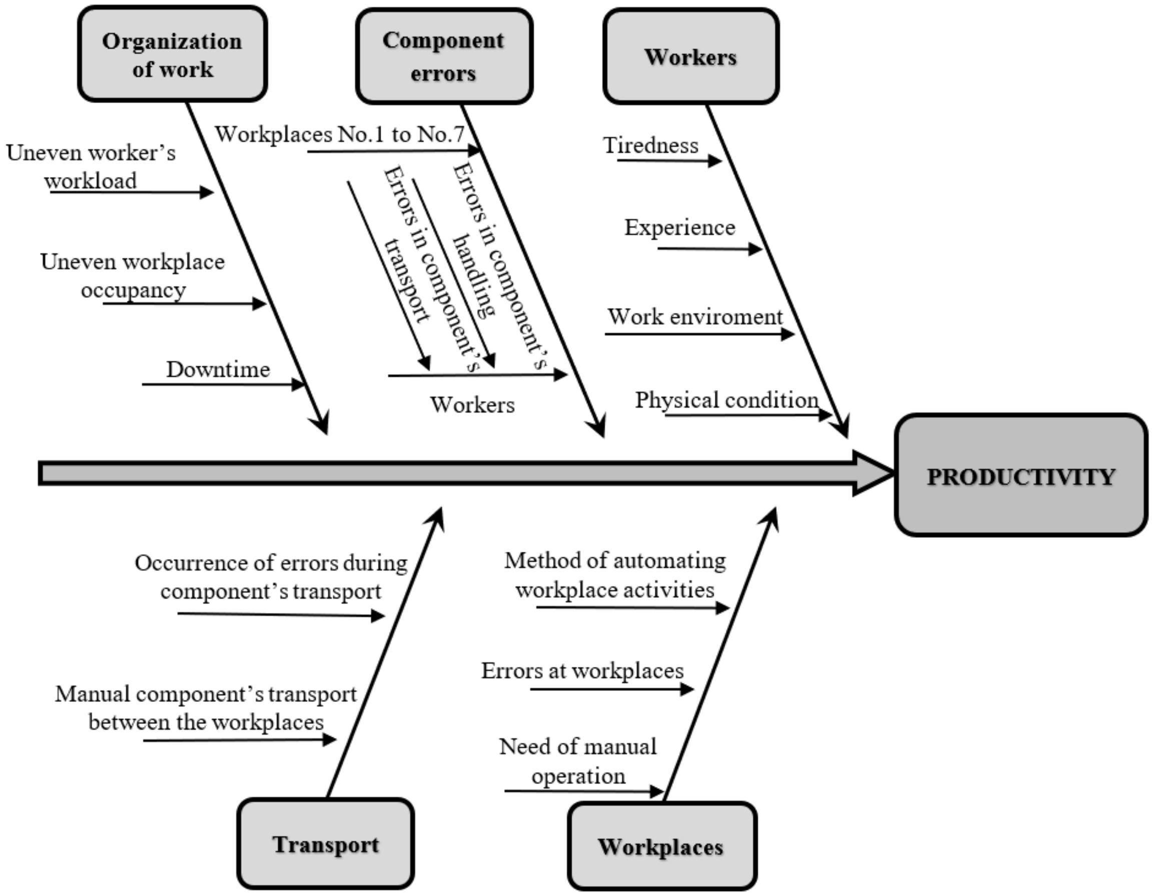

Fig. 2 – Cause and effect diagram – factors affecting productivity of a turbocharger’s assembly line. Source: own research

Fig. 3 – Disassembled component – a turbocharger. Source: own research

A turbocharger is assembled from ten components and three assembly subassemblies. The subassemblies are prepared in other assembly departments. The analyzed assembly line consists of seven operating stations (Fig. 4), where assembly, control and handling operations are being conducted by 4 operators. The first operator operates assembly station No. 1, the second operates stations No. 2 and No. 3, the third operator works at assembly stations Nos. 4, 5, and 6, and the fourth operator works at assembly station No. 7. The individual operating stations also include a fixture for the correct orientation and position of components during assembly, tools for inserting components, and elements to protect a product from damage while being produced. Automated devices mostly conduct control operations such as checking a product's pressure and tightness. They are also used to calibrate and finish turbochargers, e.g., automated screwdrivers. Part of the line is comprised of rotating intermediate operating tables, used for feeding assembly units between operators.

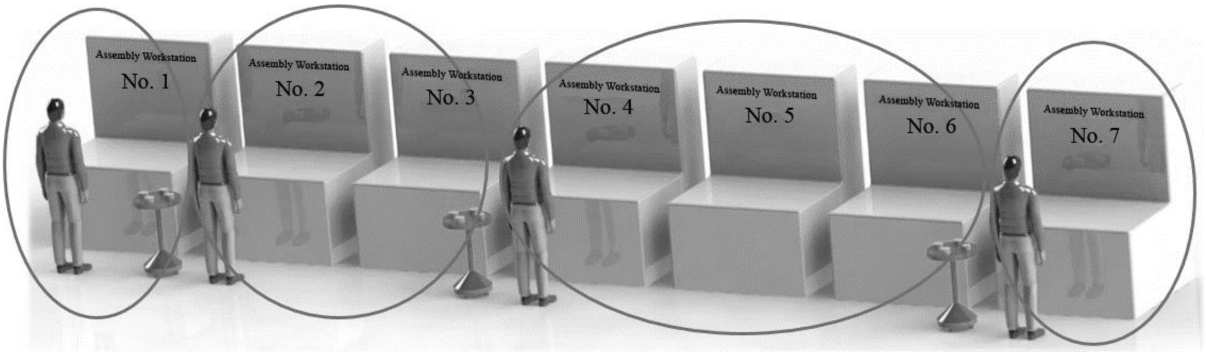

Fig. 4 – Turbocharger assembly and production line scheme. Source: own research

Inspections are part of the turbocharger assembly technological procedure. They are performed either by a worker, who mostly performs a visual inspection of the given part, or are automated test checks which are supposed to detect, for example, leaks, which could lead to a pressure drop during operation. If an error is discovered, the worker is obliged to follow the established technological procedure and remove the error (if possible) on the spot. If it cannot be eliminated on the spot, the turbocharger is classified as a defective product.

Tab. 1 shows the number of production errors by workplace that occurred during the technological assembly process and the number of their occurrence per year.

Tab. 1 – Production errors by workplace. Source: own research

| Workplace/ Operation | Error name | Designation | Number of errors per year | Time to eliminate the error [s] | Total time loss a year [s] | Total time loss a year per workplace [s] |
|---|---|---|---|---|---|---|
| No. 1/OP 10 | Damage to processed surface | OPR | 767 | 60 | 46,020 | 46,020 |
| No. 2/OP 20 | Engraving error<br>Broken barrier | NOK_G<br>BAR_P | 741<br>813 | 70<br>50 | 51,870<br>40,650 | 92,520 |
| No. 3/OP 25 | Mechanical damage to actuator | AKT | 516 | 90 | 46,640 | 46,640 |

| | | | | | | |
|---|---|---|---|---|---|---|
| No. 4/OP 30 | Incorrectly inserted Seger fuse<br>Incorrect calibration test | NOK_SEG<br>NOK_KALT | 748<br>908 | 50<br>60 | 37,400<br>54,480 | 91,880 |
| No. 5/OP 40 | NOK test of the turbine<br>NOK rotation of propellers | NOK_TUR<br>NOK_VRT | 667<br>726 | 60<br>60 | 40,020<br>43,560 | 83,580 |
| No. 6/OP 50 | NOK height of Stud M8<br>NOK screwing moment | M8<br>NOK_MK | 738<br>567 | 70<br>70 | 51,660<br>39,690 | 91,350 |
| No. 7/OP 70 | Mechanical damage to actuator<br>Damage to processed surface | OPR2<br>AKT2 | 273<br>277 | 65<br>60 | 17,745<br>16,620 | 34,365 |

Simulation software Tecnomatix plant simulation was chosen to analyze the original condition of the assembly line as well as to simulate proposed measures' impact on the line's improvement (Siemens, 2023). The bottlenecks in the production process were studies and a proposal for improvement was drawn up afterwards.

## 4 RESULTS AND DISCUSSION

From simulation results, the utilization of individual workplaces (Fig. 5) and a total production capacity of line per calendar year were determined. In its actual condition, the assembly line produces a maximum of 89,575 turbochargers per year.

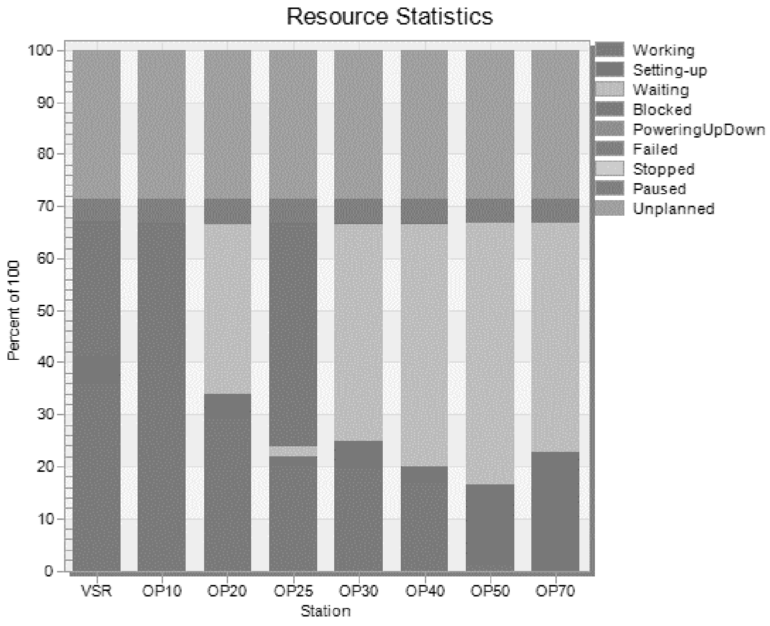

Fig. 5 – Utilization of workplaces. Source: own research

The workload of individual workers is shown in Fig. 6. The busiest is worker 3, who serves three workplaces: No. 4 (OP30), No. 5 (OP 40), and No. 6 (OP 50). This worker is a bottleneck of the assembly process since their time capacity is 100% (no downtimes). This worker's workload is not optimal regarding other workers (worker 1 with more than 90% downtime). Simulation results show a need of making changes in the workplace to reduce overload of worker 3 and more evenly distribute workload among other workers.

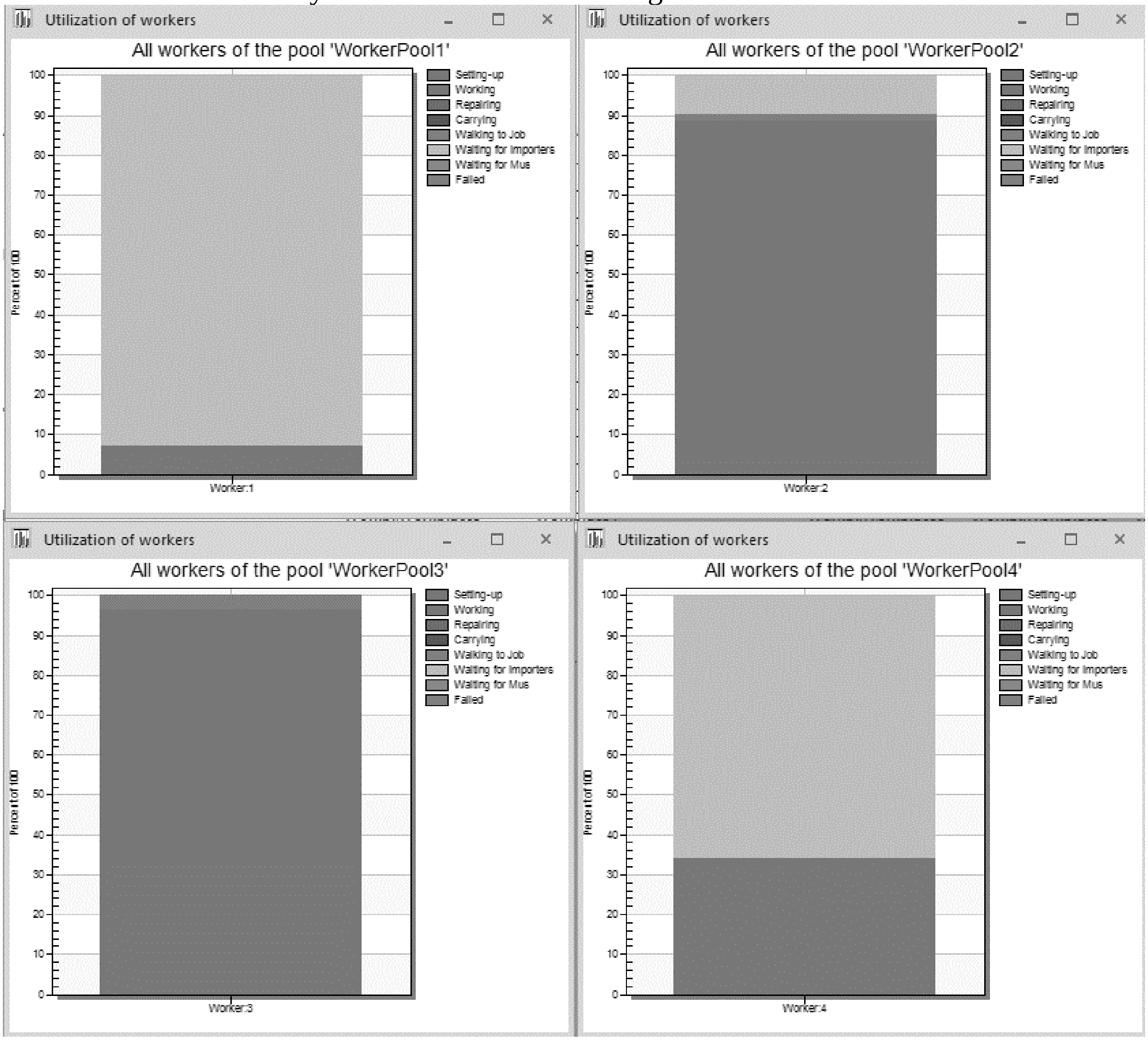

Fig. 6 – Utilization of individual workers. Source: own research

From cause-and-effect analysis, it was decided to use simulations to analyze the impact of product errors on the overall line's productivity. Errors relate to the assembled part, i.e., turbochargers, and are listed in Tab. 1, along with assignment to the workplace at which they arose. They were included in the simulation model in such a way that when defining workplaces, errors that may arise at the given workplace together with times required for repair were defined. Errors of the workplaces themselves unrelated to the assembled product were not defined since the goal was to determine the impact of assembled product errors on productivity. Simulations were successively performed in such a way that errors were deactivated at each workplace, i.e., the given workplace was considered a workplace with zero errors, i.e., with 100% quality. The results of the analyses are presented in Tab. 2.

Tab. 2 – The impact on productivity of eliminating component errors at individual workplaces
Source: own research.

| Workplace/Operation with zero error occurrence | Number of manufactured pieces per year |
|---|---|
| No. 1/OP 10 | 89,575 |
| No. 2/OP 20 | 89,575 |
| No. 3/OP 25 | 89,575 |
| No. 4/OP 30 | 89,795 |
| No. 5/OP 40 | 89,757 |
| No. 6/OP 50 | 89,767 |
| No. 7/OP 70 | 89,575 |
| No. 4/OP 30; No. 5/OP 40; No. 6/OP 50 | 90,183 |

It follows from Tab. 2 that when eliminating all errors related to the assembled product at workplace No. 1, the line's productivity remains the same as with occurrence of errors, i.e., 89,575 pieces per year. The same can be seen at workplaces No. 2 and No. 3. These results can be explained by the fact that the other workplaces have such extensive errors and removal times, that workplaces No. 1 to No. 3 are not the bottleneck, and by eliminating errors at workplaces No. 1 to No. 3, no increase in productivity is achieved. By eliminating errors at workplace No. 4, the number produced increases by 220 pieces. At workplace No. 5 it is an increase of 185 pieces, and at workplace No. 6, 192 pieces. At workplace No. 7, there is again no increase in productivity. It follows from the above that a limiting factor for the last workplace is the previous workplaces.

Based on the findings, a simulation was also conducted, during which errors were deactivated at workplaces Nos. 4, 5 and 6 at the same time. The simulation's result is in the last row of Tab. 2, making it clear that in such a condition, the line's productivity increases by 608 pieces and productivity reaches 90,183 pieces per year.

After a detailed analysis of the assembly line, also based on the above simulation results, a decision was made on modifications at workplaces Nos. 4, 5 and 6. The criterion to select these was their error rate as well as the overload of worker 3, who operates these workplaces.

The subject of the next solution is a proposal to modify assembly stations Nos. 4, 5 and 6 served by worker 3, a more detailed description of activities being performed there, and the activities of worker 3.

Worker 3 grabs the assembled turbocharger from the intermediate operating table and places it into the fixture at assembly station No. 4. During insertion, the operator must be careful not to damage it. After placing the turbocharger into the fixture, the worker places the connector on the actuator. The device automatically fixes the turbocharger by pressing the “Start” button. Then, the presence of Seger fuses is automatically being checked, and the automatic calibration of the actuator, which controls the tilting system of the turbocharger, is started. The calibration process also includes a test of airflow through the turbocharger system. After assessment of flow test's results, the actuator control unit is being calibrated to the required values through a connector based on the actuator. During the entire automated calibration cycle, the space of assembly station No. 4 is being protected by an invisible barrier formed by sensors. The operator is informed of the barrier release by a green light. When the green light is on, the operator removes the turbocharger from the preparation and moves it to assembly station No. 5, where it is put into the fixture. After leaving the invisible barrier, the turbocharger is automatically fixed, and an automatic turbocharger leak test takes place. A green light on after the end of the test allows the operator to enter the workplace. The operator removes the assembly unit from the fixture and moves it to assembly station No. 6, where it is put into the fixture. The worker then presses the "Start" button with both hands (to avoid injury), and the turbocharger gets blocked. This is followed by an automated process of inserting and screwing M8 screws to the turbine part of the unit. At the end of the process, when the green signal light is on, the operator grabs the assembled turbocharger and moves it to the intermediate operating table.

### 4.1 Modified solution proposal

Operations at assembly stations Nos. 4, 5 and 6 are currently automated, but the turbocharger is inserted manually by the operator into the fixtures at the given stations. This is why implementation of a conveyor belt was proposed for this section of the assembly line, to ensure the turbocharger's transportation between the assembly stations, and at the same time to eliminate the need for manual handling of the turbocharger (insertion and removal) at each workplace. The errors described in Tab. 1 occur during manipulation at workplaces Nos. 4, 5 and 6. Elimination of the turbocharger's manual handling brings elimination of errors. The conveyor's design and implementation are shown in Fig. 7.

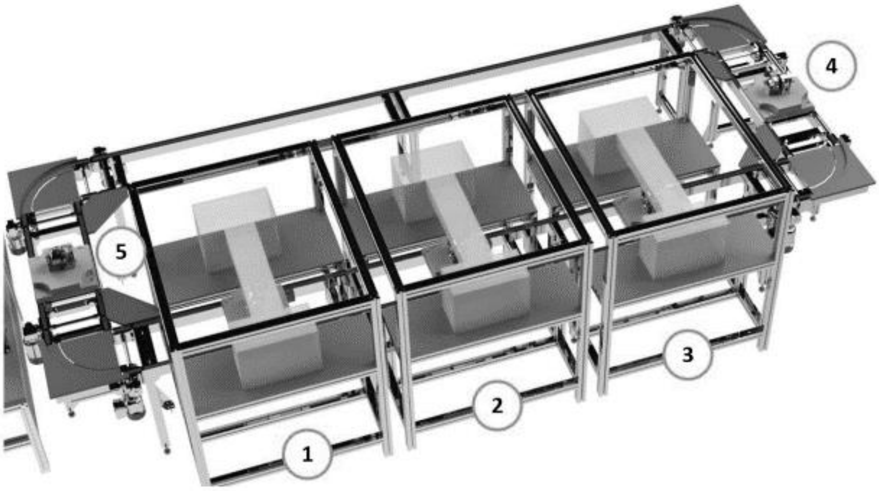

Fig. 7 – CAD model of stations Nos. 4, 5 and 6 with a conveyor belt. Source: own research
1 - assembly station No. 4; 2 - assembly station No. 5; 3 - assembly station No. 6; 4 – place of removal of the assembly unit from the pallet; 5 - place to store the assembly unit on a pallet.

### 4.2 Description of a work cycle at assembly stations Nos. 4, 5 and 6 after modification

The turbocharger coming from workplace No. 3 is inserted by a collaborative robot into the fixture attached to the pallet of the conveyor belt. Then, the pallet with the turbocharger is being transported to the assembly station No. 4. At this point, the mobile pallet with the assembly is stopped by using a stop gate. After the pallet stops, a positioning unit is started, which lifts the pallet with the installed turbocharger into the position in which the assembly, calibration and control operations are being performed automatically. After the end of automated process, the positioning unit lowers the pallet with the turbocharger onto the conveyor belt, with the help of which it is further transported to assembly station No. 5. The process of transportation, stopping, positioning and execution of processes using automated devices is, at assembly stations No. 5 and No. 6, performed in the same way as at assembly station No. 4. The nature of performed actions and cycle times of automated devices at individual assembly stations remain unchanged. After completion of the assembly process at operating station No. 6, the turbocharger is being transported to the positioning unit, intended for its removal from the conveyor belt. The worker servicing the next station, No. 7, removes the turbocharger from the preparation on the mobile

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pallet and moves with it to station No. 7, at which a visual inspection is performed. The empty pallet is then transported to the positioning mechanism, located near station No. 3, and serves for loading another turbocharger onto the pallet. After the empty pallet arrives at this position, the automated cycle between operating stations Nos. 4, 5 and 6 is completed. The next cycle begins when the collaborative robot places another turbocharger on a mobile pallet.

### 4.3 Modified simulation model of the assembly line

To verify benefits of a newly designed assembly process, a modified simulation model was created with all the proposed changes (Fig. 8). Due to fully automated workplaces Nos. 4, 5 and 6, the third worker was completely excluded from the assembly process.

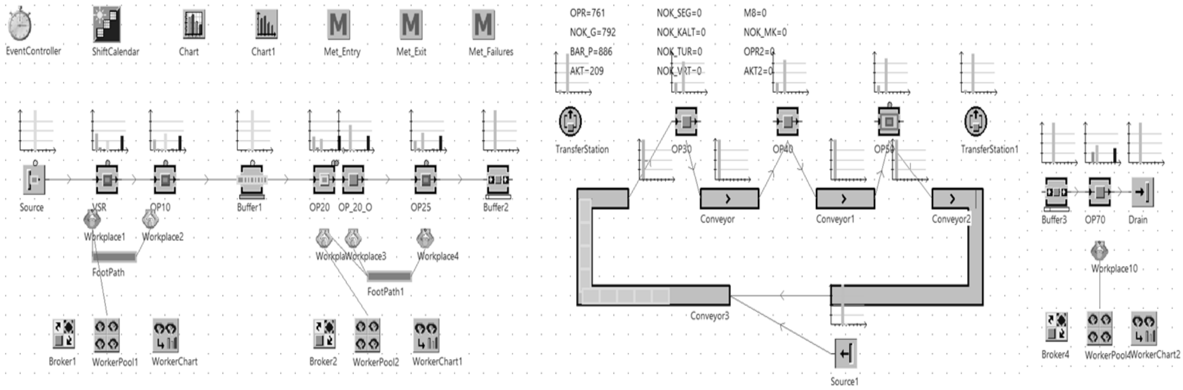

Fig. 8 – Modified simulation model of a turbocharger assembly line. Source: own research

After starting and ending the simulation, a change in use of workplaces Nos. 4, 5 and 6 was identified. The largest increase in the use of workplaces occurred at workplace No. 6, by about 15% (Fig. 9). There was also an increase in the annual production of the assembly line from 89,575 pieces to 98,139 pieces, which is 8,564 pieces more, i.e., an increase of 9.56%, while reducing the number of workers from four to three.

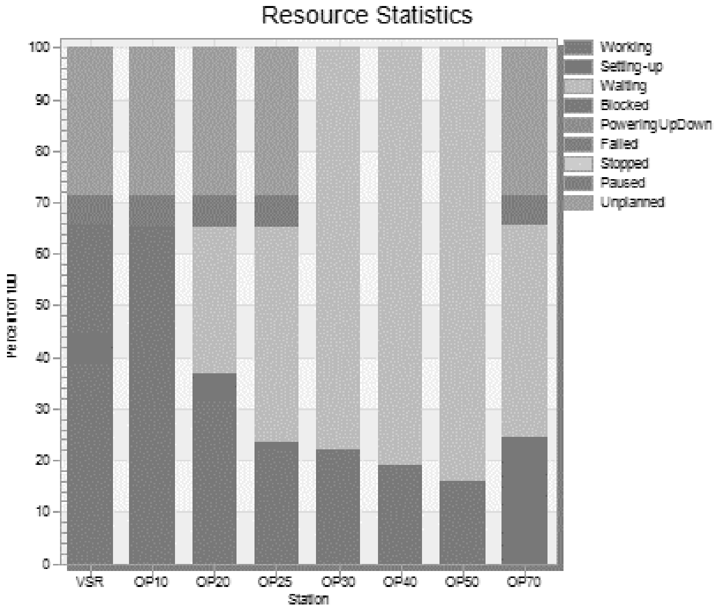

Fig. 9 – Utilization of workplaces. Source: own research

Due to maintaining the original job content, the workload of the first and fourth workers did not change. The workload of the second worker (Fig. 10) has increased, as that worker is no longer obstructed by the third worker, whose activities were replaced by automation. In the modified model, the second worker became the line's bottleneck. Addressing this bottleneck will be the subject of future research.

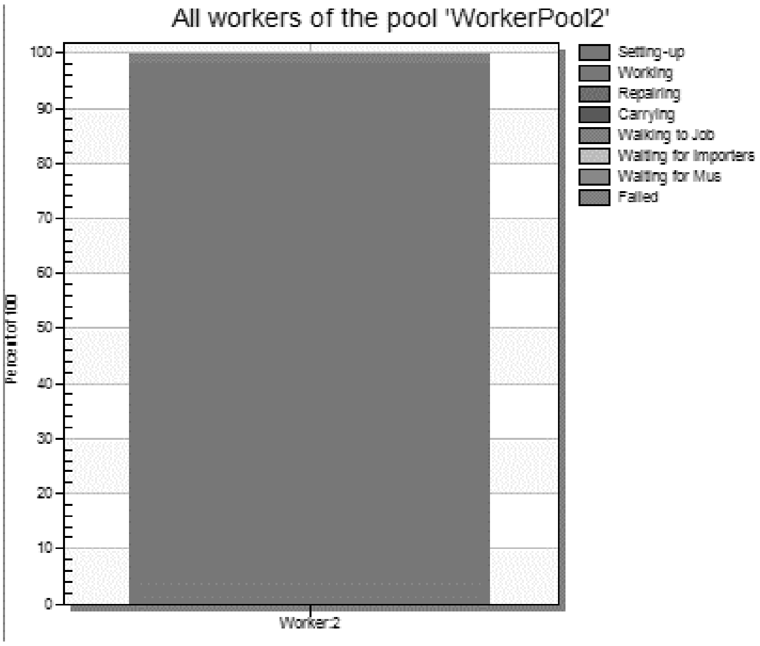

Fig. 10 – Workload of worker No. 2 in a modified simulation model. Source: own research

Reshaping of the assembly line's section between assembly stations Nos. 4 to 6 to a fully automated one brought a reduction in the number of workers needed to operate the assembly line, from four to three. This number is achieved due to the fact that the third operator's manual activity, i.e., servicing of assembly stations Nos. 4 to 6, will be fully replaced by automated devices. The proposed measures will also increase the assembly line's productivity, while at the same time reducing the number of workers, and thus contributing to increasing the company's competitiveness. A number of errors will be eliminated, too. In this way, competitiveness can increase, reaching an annual production of 98,139 turbochargers.

The simulation has confirmed that the proposed measures would result in increased productivity. Without simulation, the assessment of proposed measures' benefits would be more demanding, and lengthy. The simulations allow us to analyze "what if" scenarios in a brief time, and thus more quickly assess the benefits of several variants of changes. It then allows the companies to assess proposed measures in relation to the costs/benefits ratio and opt for the most suitable solution at a given time and circumstance. Since the markets are changing dynamically, so are the conditions. Thus, a solution ideal at a given time and place may no longer be ideal after some time, and a new ideal solution needs to be found. Once an accurate production process model is created, it is easier then to change it, accordingly, thus constantly adapting to what is most appropriate under the given circumstances, in terms of the company's competitiveness.

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# 5 CONCLUSION

One of basic trends in increasing the competitiveness and innovation potential of companies nowadays is a systematic costs reduction in all phases of a product's production cycle, currently with an emphasis on its energy efficiency. Another challenge for manufacturing companies is a need to quickly respond to ever-changing customer needs, market changes triggered by unpredictable circumstances, resulting in recessions and economic crises. The trend is a constant shortening of new products' launch time in the market, with an emphasis on maintaining and increasing required quality and achieving competitiveness. These factors are related to a shortening of time for rebuilding machines and production lines, with the onset of Industry 4.0 oriented on smart production and smart products. Therefore, companies coping with these challenges are seeking ways to optimize engineering activities and shorten the time of rebuilding production lines and putting them into operation, which is closely related to increased product diversification. Simulation software is an extremely effective solution to these problems and challenges, helping to significantly shorten the time needed to fine tune and put the modified production lines into operation, or assess the introduction of new automation solutions, followed by an effectiveness assessment of the proposed solutions, in terms of savings and productivity in economic terms. The result and goal of simulation software application and use is an increase in overall production effectiveness, as one of the basic prerequisites for companies' competitiveness.

Simulations enable verification of proposed measures' effects on production before the actual implementation, thereby preventing errors. However, even the best intention of improvement can be risky if some factors are overlooked. The later the error is discovered, the greater the problems associated with its removal. Also, creation of real line models helps increase awareness of interconnections, continuity, and interaction in production processes, helping to better understand them and propose changes accordingly. By creating a model and applying simulation, the actual condition of an assembly line was analyzed in the Tecnomatic plant simulation software. Based on the analyses, measures were proposed to increase production efficiency and the company's overall competitiveness. The proposed measures having been simulated, it was discovered that after their application, the productivity increases by 9.56%, while reducing the number of workers from four to three. In the future, a further increase in assembly line efficiency is planned, focusing on workplaces No. 1 to No. 3 and workplace No. 7., so as to positively affect the company's overall productivity and competitiveness.

Other measures to consider for achieving increased competitiveness include automation of other sections of the assembly line, such as application of assembly fixtures helping to reduce time, reduce errors and thus production costs.

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