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# The use of the TWI Method to Improve Safety at the Work Station

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## INTRODUCTION

The aim of the publication is to present the results of the analysis of activities performed on the assembly stand in the aspect of identification and elimination (or limitation) of possible direct and indirect causes of hazards that may lead to accidents at work. In order to eliminate or limit hazards occurring at the analyzed stand, a four-step TWI – Job Safety method was used. In the first stage of the method, threats were identified, and then in the second stage remedial measures were proposed. In the third stage of the TWI method, the proposed solutions were put into practice. The fourth step of the method is not presented in the paper, i.e. the evaluation of results – the results will be verified by the company in the future. As a research method, a case study was chosen due to the usefulness of solving problems in the field of business process management as well as the methods and tools used, in order to make rational and effective decisions (Piekkari & Welch, 2011). The source of the data was the information provided by the company and own observations.

## LEAN MANUFACTURING

Dynamically changing conditions for business operations, development of new technologies and increasing competition put enterprises ahead of increasingly difficult requirements, especially as the complexity of the market environment and its instability increase uncertainty when making decisions. Therefore, enterprises use different concepts that will enable them to solve problems by producing high quality products for a demanding customer (Grabowska & Furman, 2015). One of them is the Lean Manufacturing concept. The Lean Manufacturing (LM) philosophy is applied in different kinds of companies and their branches (Antosz & Stadnicka, 2017). LM means making production less demanding in terms of necessary material resources, kept ready product stocks and production in progress as well as used area of production floors. It is an enterprise improvement conception which, through continuous elimination of various forms of wastage, optimizes creation and flow of value in the

manufacturing process. There can be seven categories of wastage distinguished: over-production, standstills, failures, redundant operations, improper processing, excessive stocks, redundant internal transport. This list includes also failure to use employees' creativity, as they can be a source of ideas regarding process improvement which contributes to a great extent to elimination of wastage (Furman & Burchart-Korol, 2008).

All employees take part in Lean Manufacturing actions including the company's managing director and machines operators. With the help of trainers-specialists special teams are created, who analyze current wastage, plan its reduction and implement already planned actions. By engaging more and more people in team-work activities and providing time for problems solving the company undergoes transformation of its working culture and succeeds in implementing Lean Manufacturing idea.

There are five principles of the Lean Manufacturing concept: (Antosz et al., 2015):

- accurately define value of a certain product,
- identify the values stream for each product,
- guarantee untroubled flow of values,
- implement of sucking system,
- drive to be perfect.

The Lean Manufacturing concept offers many useful tools that allow effective and efficient implementation of the "lean" management model in an enterprise, as well as undertaking further improvement activities in each of its areas. A management system based on the Lean concept must be designed in such a way that it takes into account the conditions inside and outside the functioning of the organization, while realizing its vision and mission. The choice of Lean tools depends on the conditions and know-how resources in the enterprise (Kubis, 2005). The most frequently applied tools of Lean Manufacturing concept are (Furman et al., 2017):

- VSM (Value Stream Mapping) – the method of production process mapping which presents the flow of materials and information in the course of the process (Stadnicka & Litwin, 2017). On the basis of executed map of the process, it is possible to verify the production capabilities of the enterprise and identify risks which theoretically result in stoppages and delays in analyzed manufacturing process. This tool suggests the application of adequate solutions in terms of Lean in order to remove wastes and improve activities.
- Kaizen – the method of constant improvement of the production process and organizational systems which is divided into stages, based on the analysis of selected activities concerning defined areas of activity of the production enterprise.
- visual management (Knop, 2016) – is a set of practices facilitating the management of the production process through the rapid detection of irregularities, includes every communication tool used in a work environment

that allows you to specify how a job should be done and whether the method of its implementation differs from the standard set.

- 5S method – constant process allowing arrangement of the work environment through the implementation of 5 stages of activities (sort, set in order, shine, standardize, sustain) the application of which makes it possible to achieve order and improve the level of safety. In most cases, this method is applied as a type of supporting tool in the identification of mistakes and defects which occur in the selected workplaces.
- SMED (Single Minute Exchange or Die) – the method aimed at shortening the time for the implementation of machines conversion by the application of standardized organizational activities which minimize the number of necessary operations to execute the conversion.
- TPM (Total Productive Maintenance) – TPM is defined as a continuous process of servicing machinery and equipment implemented within the entire enterprise by all operators and maintenance technicians. TPM focuses on maximizing the efficiency of the machinery by applying actions to prevent accidents during the whole period of application.

The basis for the different concepts, methods and tools of process management is the need to improve these processes. The important element of process improvement is also the work safe aspect (Małysa et al., 2016; Małysa et al., 2017) – implemented improvements should include safe working conditions and reduce the number of potential accidents.

It is believed (Kovacova, 2012) that the starting point for modern production concepts that have developed into the most promising methods in today's industry is the TWI program, now identified with the Lean Manufacturing concept.

## TRAINING WITHIN INDUSTRY

Training Within Industry Method (TWI) is a program supporting the development of managerial skills among experienced operational employees and low- and middle-level supervisors. The genesis of the TWI goes back to the early 1940s, when after the invasion of Nazi troops into France in June 1940, in the US it was realized that war was inevitable. A big threat to the US was that the engagement of US troops in the war meant the recruitment to the army of most American men of working age who had previously worked mainly in the industry. The TWI program aimed to involve people who had never worked in the production area before working in the industry. They were mainly women, as well as men of non-occupational age and administrative employees. The program was mainly directed to supervisors who were responsible for the work of directly production employees. The aim of the TWI program was to practice in them the skills of instructing employees, improving working methods and maintaining good relations with employees, in order to achieve an increase in productivity, quality and work safety. Each of the methods (modules) of the TWI program was based on the Deming cycle (Misiurek, 2014)

It is worth noting that in fact the creator of the concept underlying the TWI was Charles Allen, who developed the principles of vocational training in the shipbuilding industry during World War I. The training methodology developed by him was based on a four-stage process including: preparation, presentation, application and testing. Similarity to the PDCA (Plan-Do-Check-Act) cycle can be noticed (Liker and Meier, 2008).

Because the TWI program was a military program, after the end of the war it ceased to be used in the USA (many temporary workers were replaced by more experienced returning soldiers). The program was transferred to Japan, where it was widely used, among others by Toyota, which used TWI as a basis for developing its production methods. The TWI program became the foundation of the "Toyota house", in which it took responsibility for the stabilization and standardization of processes (SMED, TPM, 5S, responding to problems). Currently, the TWI program is identified with the Lean concept and often used by companies implementing Lean solutions (Misiurek, 2014). The TWI method should be used by all companies for which knowledge management is one of the strategic goals (Gajdzik, 2008).

**Modules of the TWI program**

The structure of the TWI program is based on three basic modules: Job Instruction (JB), Job Methods (JM), Job Relation (JR) and on a module based on work safety – Job Safety (JS) (Fig. 1).

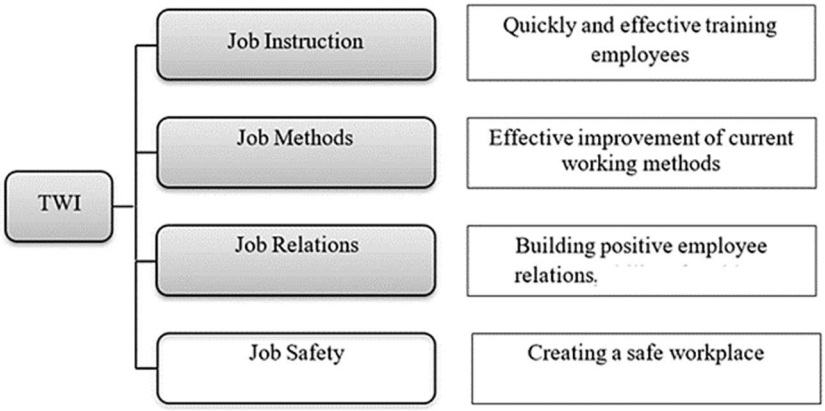


**Fig. 1 Modules of the TWI program**

Source: (own elaboration)

TWI – Job Instruction is a way of effectively instructing employees how to properly, consciously and safely perform their tasks. Using this approach, supervisors are able to quickly and effectively train new employees, which should lead to elimination of errors and productivity growth. This method covers not only the time of conducting the training, but also the stage of preparing the employee for briefing and supervising them when they perform the work themselves (Horbal & Misiurek, 2009). The correct training includes four stages: preparing the employee, presenting the operations (giving main steps, tips and reasons), testing the effectiveness (checking the employee), and control (Liker & Meier, 2008).

TWI – Job Methods leads to improvement of the way of working for continuous improvement (kaizen). The goal of the program is to produce more quality products in a shorter time, by making the best use of people, materials and machines. Participants learn how to divide work into components. Every detail is carefully analyzed to generate ideas for improvement. Eliminating, combining and simplifying steps in the process leads to the development of new working methods (Kovacova, 2012).

TWI – Job Relations is a set of good practices in managing people. This program is based on the assumption that most supervisors have average leadership skills that can be practiced using appropriate methods. TWI-JR consists of four steps of correct handling of subordinates in the process of solving problems: gathering facts, analysis of potential solutions, their consequences, choice of solution, taking action and checking the results of the action. The method also allows supervisors to build solid, good relationships with their employees, incl. informing employees about changes, praise for properly performed work, skilful use of employees' potential (Hojka & Horbal).

TWI – Job Safety is a complementary program focused on environmental health and safety. JS provides a framework for supervisors to engage employees in identifying potential hazards and eliminating them in conjunction with their training and knowledge in OHS regulations. TWI-JS was developed in Japan and, although it was not part of the original TWI program, it plays a critical role in industry today. This program teaches supervisors a method to analyze the chain of events leading to accidents and hazardous situations. Root causes are identified and remediated to "break the chain" (Fig. 2). JS stresses that the relationship of the supervisor and employees plays a pivotal role in a safe and environmentally responsible workplace (Kovacova, 2012).

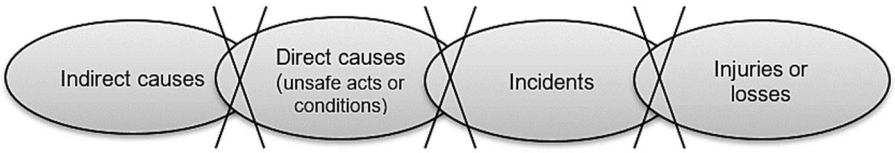


**Fig. 2 The broken chain of events**

Source: (Job Safety)

### Stages of the TWI-JS method

The TWI-JS method is based on four steps and its aim is a methodical approach to hazards identification and subsequent undertaking of activities related to these hazards, according to the Deming cycle (Misiurek, 2011):

1. Step 1 – identifying places that may cause the threats (Plan). The aim is to analyze the work area in the aspect of identifying possible direct and indirect causes of hazards. While performing the first step of the method, one should go to the analyzed workplace and follow the guidelines presented in Fig. 3. The first step should be getting familiar with the register of accidents and hazards that occurred in the given work area. The aim is to obtain detailed knowledge of the conditions at the workplace. After obtaining information from the registers, one should check the regulations and work standards according

to which the operators work. This analysis requires interviewing employees and/or other persons familiar with the scope of work, because due to their experience and knowledge, they can indicate particularly dangerous places. Then, the workplace analysis should be carried out in the aspect of existing hazards (in cooperation with operators). The hazard identification sheet is the tool used for the analysis.


**Fig. 3 Procedure pattern on the first stage of the TWI-JS method**
Source: (Misiurek, 2011)

2. Step 2 – identifying the countermeasures for all hazards (Do). The main goal is to adapt appropriate remedies to the risks identified in the first step. The analysis should be carried out with the participation of employees. The analysis of hazards should start with proposing a method of their elimination, if it is possible. If this is not possible, technical measures should be defined. Nevertheless, the introduction of such a measure does not absolve the superior from further analysis of hazards. Visual warnings should be prepared, which will be placed at the workplace, and then a training in the form of a toolbox talk should be performed. The most effective remedy is elimination of the hazard, the least effective – the use of personal protective equipment. They are an important preventive element, but they should be implemented only in situations where it is not possible to avoid or sufficiently limit hazards using other remedies. The selected countermeasures should be verified with the applicable rules, regulations and standards.
3. Step 3 – implementation of remedies (Check). During the implementation of remedial measures, the emphasis is put on the independent work of the supervisor, who should be most concerned with the elimination or reduction of risks. The implemented activities can be divided into immediate and long-term ones. Immediate actions are implemented very quickly due to the need to immediately eliminate or reduce hazards in the workplace. Long-term activities usually require a detailed analysis.
4. Step 4 – results control (Act). A stage involving the assessment of the obtained results. It includes activities such as: conducting audits, paying

attention to and responding to deviations from health and safety regulations, employee involvement in systematic OHS inspections.

## THE USE OF THE TWI-JS METHOD FOR IMPROVING SAFETY AT A WORK STATION – CASE STUDY

The process of gluing mirrors into the frame, where two operators work (Fig. 4), is carried out at the analyzed workstation. It is work in a forced position (standing, walking, repetitive activities by hand).

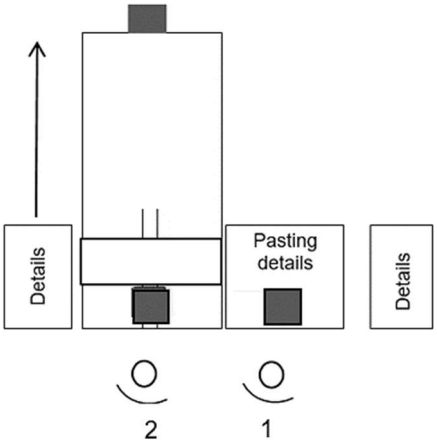


**Fig. 4 The scheme of workstation**

The gluing process takes place on the machine. The no. 1 operator's tasks include picking from the palette of painted frames and mirrors and visual control of their quality. Tasks of the operator no. 2 include the preparation of gluing elements from the operator no. 1, placing the frames with mirrors on the conveyor and checking the location of the glue and the connection of the surfaces.

The analysis of work safety at the station was carried out according to the 4-stage TWI-JS method. Getting familiar with the production process and activities performed by operators in this position were a part of the analysis.

Due to the limited possibility of data publication, the study did not include all the results of research and photos.

### Step 1 – hazard identification

In the first step, the analysis of the work stand was carried out in the aspect of identifying all possible hazards that may occur. A register of accidental and potentially accidental events was analyzed – according to data from 2018, three accidental events (finger injury, body contusion, hand burn), and one potentially accidental event (work with moving machine elements) took place at the work stand. Only amendatory actions in the form of employee training were undertaken without any corrective actions.

Then, the regulations and work standards relating to the work stand were reviewed. An interview was conducted with operators and people familiar with the scope of the performed work. The analysis showed that there is one

redundant document not used by the operators on the analyzed stand (safety tips for manual tool operation). This is due to the reorganization of the work station from manual execution of the automatic option.
In the next stage, the safety at the position was analyzed in the aspect of existing hazards. To this end, a hazard identification sheet was used (Table 1).

**Table 1 A fragment of the risk identification sheet at the work station**

| No. | Type of risk | Is there any risk? | Risk description | Current ways to eliminate risk |
|---|---|---|---|---|
| 1. | Risk related to non-compliance with the rules of work ergonomics (work in an uncomfortable or forced position) | **Yes** / No | Forced posture at work (standing, walking, repetitive activities by hand) | Additional break |
| 2. | Risk associated with moving machine elements | **Yes / No** | Movable elements of the conveyor | The use of work wear, focus on the activities performed, coordination of team work, repair and maintenance during machine shutdown |
| 3. | Risk associated with sharp edges, rough surfaces, etc. | **Yes / No** | Sharp edges of mirrors | Use of personal protective equipment (protective gloves), concentration on the activities performed, caution |
| 4. | Risk related to physical and static loading | **Yes / No** | Manual transfer of frames and mirrors to the station | None |
| 5. | Risk associated with the movement of people | **Yes / No** | Bad workplace organization (mirrors placed on the wrong side of the post)) | Focusing attention on the activities performed, coordination of team work, caution |
| 6. | Risk related to fire and / or explosion | **Yes / No** | Flammable materials (varnished frames) | Compliance with the rules contained in the fire-fighting instructions, a total ban on smoking, the use of technically efficient devices, installations, fire-fighting equipment |
| 7. | Risk related to hot or cold surfaces, materials, etc. | **Yes / No** | Hot glue | The use of work clothes and personal protective equipment (protective gloves), caution |
| 8. | Risk related to electric current | **Yes / No** | Devices powered by electricity, circuit breakers and connections | Regular measurements of the effectiveness of the machine's fire precautions (every 2 years and after each change of the machine's location) |

Source: (own elaboration)

The analysis showed that there are eight types of hazards related to the stand: non-compliance with the principles of work ergonomics, moving machine parts, sharp edges, physical-static load (manual transport), human movement, electric current, fire and/or explosion, hot surfaces.

### Step 2 – remedies identification

Countermeasures have been suggested to the risks identified in the first step. Priority hazards were those that led to accident events or were recorded as potentially accidental events, i.e.:

- risk related to the movement of employees, which led to the collision of two operators and resulted in body bruising – the threat can be eliminated by reorganizing the workstation, consisting of transferring the pallet with mirrors to the other side of the station and placing them next to the pallet with the frames. It is also necessary to develop a new standard of work and conduct training,
- risk associated with sharp edges, which led to cutting the finger with the edge of the mirror – the proposed solution is to introduce changes to the current OSH instructions, develop a new standard of work alerting to the threat, placing additional visual markings and conducting training,

- risk associated with hot surfaces that led to hand burns – the proposed solution is to introduce changes to the current OSH instruction, to put additional visual signs informing about the threat and to conduct the training,
- risk associated with moving parts of machines that could lead to the worker being screwed in – the proposed solution is to mount covers on moving parts of the machine, develop a new standard of work paying attention to the threat, place visual markings informing about the threat and conduct training,
- risk of non-compliance with the rules of work ergonomics – the proposed solution is to introduce employee rotation between positions and provide them with the opportunity to sit or rest near the workplace,
- risk connected with physical and static load (manual transport) – the proposed solution is to develop a new standard of work that draws attention to the threat and to conduct training for employees in the area of safe lifting techniques and a new standard of work,
- risk related to electric current and fire and/or explosion – the proposed additional solution is to introduce changes to the current OSH instruction and to conduct training for employees regarding the introduced changes.

**Step 3 – implementing countermeasures**

The third step of the TWI-JS method consists in implementing the proposed solutions. In accordance with the proposed remedies, additional provisions were introduced to the applicable OSH instructions (in general provisions, in prohibited activities). The instructions were approved by the employer and then the operators were trained. In addition, supplementary visual notifications informing about a given threat have been introduced, thanks to which operators identify certain events more easily and, as a result, they react to incidents faster.

**Table 2 A part of work standard according to TWI method at the analyzed work station**

| OPERATOR No. 2 | | | | | |
|---|---|---|---|---|---|
| **No.** | **Main steps** | **No.** | **Tips** | **No.** | **Causes** |
| 1. | Take the elements for gluing from operator no. 1, place the mirror in the frame | 1.1. | Place the mirror in the frame recess | 1.1.1. | It results from technical conditions |
| | | 1.2. | Using protective gloves | 1.2.1. | You will avoid cuts if you encounter the broken edge of the mirror |
| 2. | Put the frame with a mirror on the conveyor of the gluing machine | 2.1. | The hole is directed to the runner | 2.1.1. | It results from technical conditions |
| | | 2.2. | Being careful about the moving elements of the conveyor | 2.2.1. | You will avoid pulling in by moving parts of the machine |
| 3. | Check the glue spread and the connection of the surface | 3.1. | The glue must be spread evenly, the surfaces must be joined | 3.1.1. | It results from technical conditions |

Source: (own elaboration)

As part of step 3, new work standards for operators were also developed according to the TWI methodology, taking into account the assumptions of the TWI-Job Instruction module. The proposed standard of work precisely specifies the activities performed by operators, because it divides the work into the main steps, tips and reasons for the occurrence of these guidelines. According to this approach, when developing the standard, the focus was not only on the description of the method, but mainly on recording the way of working along with justification. Thanks to the explanation of the hints and reasons for their occurrence, it is possible to eliminate errors of operators that affect the quality and safety of the work performed. An important element of the standard are photos showing the way of work (tips). The standard of work also included a change in the organization of the workstation consisting in transferring the palette with the mirrors to the other side of the workplace and placing them next to the palette with the frames. An organized workplace will eliminate the risk related to the movement of employees. The proposed work standard also includes safety guidelines that reduce the risks associated with moving machine parts, sharp edges and physical-static loads. A fragment of the developed standard of work according to the TWI method is presented in Table 2 (due to the confidentiality of information, no photos showed).

An important element of implementing the proposed solutions is employee training. In the case of work standards, it is not recommended to provide information before the instruction, as learning is ineffective. According to the TWI methodology, the most effective way of the employee to acquire knowledge is to look at the work and simultaneously listen to the verbal description of all points passed by the supervisor.

## CONCLUSION

For a proper functioning of the production process, its continuity and lack of interference are necessary, and any accident at work causes the interruption of this continuity (however, any production process can be harmful to the employee's health (Skuza et al., 2011)). Man plays a superior role in the production process – they are responsible for its proper functioning, for process safety and work safety (Krupa et al., 2018). The direct superiors of production workers should be responsible for improving work safety, and they should also be supervised by their superiors to set a good example for operators. The use of the TWI-Job Safety method by superiors allows for creating safe working conditions. Following the 4-stage TWI-JS method, the analyzed workplace identified threats for which solutions were proposed and implemented to eliminate or reduce these hazards, including: change in the organization of the work station, introduction of changes in OSH instructions, development of a new standard work according to the TWI rules, introduction of additional visual signs informing about hazards, additional training based on the TWI instructional model. The results of the last stage related to the control of results, which the company will carry out individually, are not presented in the article. The use of the TWI-JS program is an effective tool for OSH services to improve work safety.

It is worth emphasizing that the ability to use the TWI program and the methods and tools of the Lean Manufacturing concept can bring many benefits to the company.

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**Abstract.**
Ensuring work safety in manufacturing enterprises is one of the employer's basic obligations under legal provisions. Actions taken in this area translate into a reduction in the number of registered accidents at work, occupational diseases or potentially accidental events. Limiting these types of events is possible by implementing preventive solutions to reduce the risk, employers 'and employees' cooperation in the field of occupational health and safety. These activities may take the form of technical solutions, but above all organizational. Enterprises use various management concepts that have an impact on improving work safety. One of the solutions eliminating or reducing hazards occurring at workplaces is the TWI (Training Within Industry) program. The TWI program is the foundation of a management culture based on continuous improvement and a continuous learning process. It is considered the starting point to implement the Lean Manufacturing concept. One of the TWI modules is aimed to creating a safe workplace, i.e. TWI-Job Safety (TWI-JS). The publication presents the results of the analysis of operations performed at a selected workstation in the production enterprise in the aspect of identifying and eliminating or limiting possible direct and indirect causes of hazards that may lead to accidents at work. For this purpose, a four-step TWI-JS method was used.

**Keywords:** the TWI method, Lean Manufacturing, work safety