# Video Based Work Instructions (VWI) and its Role in Improving Employee Training, Cross Training, And Productivity in Small and Medium Manufacturing Enterprise

**Kuldeep Agarwal and Pawan Bhandari**
Department of Automotive and Manufacturing Engineering Technology
Minnesota State University
Mankato, MN 56001, USA
kuldeep.agarwal@mnsu.edu; pawan.bhandari@mnsu.edu

## Abstract

One of the biggest challenges facing small and medium manufacturers in today's economic environment is the recruitment and retention of talent across all functions in an organization. It is extremely challenging to find and keep shop floor associates as welders, painters, machinists, and assemblers. Even if an organization can hire skilled personnel, training them on specialized equipment and work practices takes a lot of effort and time. Work instructions (WI) or standard operating procedures (SOP) are a set of instructions that enumerate all the steps and activities required to complete a job. Traditional WI or SOP suffer from many disadvantages: they are hard to control, difficult to understand in many situations, time consuming to create and maintain, and do not capture the tacit knowledge of trained employees effectively. To overcome the challenges posed by regular SOP, a new way of creating them has gained traction in the last few years called Video Work Instructions (VWI). In this approach, a video of the manufacturing process is taken while the operation is being carried out. The video is later edited to include the work instruction in the frames during the actual operation. In this project, VWI was created for a medium manufacturer in Southern MN for welding and assembly processes. The VWI was later used in employee training and cross training. It was found that there was a reduction of the new employee training period by approximately 50% and a productivity increase by approximately 12%. This paper will talk about the advantages and challenges associated with such an approach.

## Keywords

Video Work Instructions, Productivity, Training, Cross Training, and Standard Operating Procedures.

## 1. Introduction

One of the biggest challenges facing small and medium manufacturers in today's economic environment is the recruitment and retention of talent across all functions in the organization. It is extremely challenging to find and keep shop floor associates such as welders, painters, CNC (Computer Numerical Control) machinists, and assemblers. Even if an organization can hire skilled personnel, training them on their specialized equipment and work practices takes a lot of effort and time. Training period can vary from a few hours to months depending on the complexity of the task. The problem is compounded by the fact that a significant percent of knowledge in these jobs is tacit (internal to the trained employee) in nature and is difficult to transfer to a new person. The aging pop population of skilled machinists, welders, and other machine operators who will be retiring soon has ended this problem. Many of the small and medium manufacturing enterprises also operate as job shops and deal with high mix low volume production. This arrangement forces them to move shop floor employees among varied tasks depending on the needs of the product and production schedule. Hence, both employee training and cross training are crucial in the success of this industry.

## 2. Problem Description

There are several methods used for new employee training and existing employee cross training in the manufacturing industry. These methods include job shadowing, standard work instructions, seminars, and hands on training. These methods rely on the existing knowledge of the trainee and are either time-consuming or cost prohibitive or both. There are a lot of benefits to both employer and employees but there are also disadvantages and concerns for employers in

cross-training (Abrams & Berge, 2010). Most of these methods also fail to capture the tacit knowledge of the employee who is currently the expert on the process and hence does a poor job in transferring this knowledge to the new employee.

Thus, there is a need for a new system of training and cross training method which will help in mitigating the above-mentioned issues. The training method should be flexible in capturing the tacit knowledge of employees and should be able to easily transfer this knowledge to novice and other employees. This training method should also be easily accessible to all employees in the organization and should be self-learning so that time wasted on training can be reduced. One of the ways this training can be achieved is by using video-based work instructions (VWI). This method of creating work instructions helps in training and cross training of employees and reduces the time it takes for a new employee to be productive on the shop floor. Gegenfurtner, Zitt and Ebner (2019) conducted a study to understand the impact of webinar-based digital training method with participants from four different industries: supply chain management, industrial management, early childhood education, and mathematics. Authors found that early childhood education trainees had the highest satisfaction levels. Most trainees liked the fact that they were able to go back and watch the recording in some areas of the training. VWI is similar in that the videos are short and to the point clips so trainees can go back and watch it anytime they want to help them learn quicker in their respective areas. Video-based and online learning also became popular during the onset of COVID-19 pandemic. Another study validated the effectiveness of digital learning environments in higher education and professional training settings. The first of its kind metaanalysis performed by the researchers in the effectiveness of webinars and video conferences showed positive outcomes (Genenfurtner & Ebner, 2019). Use of digital technologies have proven to be beneficial for conducting training in adult education and human resource development in a lot of companies. Not everyone is ready for digital form of training due to the lack of competency among the workers but once they are trained in the respective technology being used to conduct the training, the outcome can be beneficial (Gegenfurther, Schmidt-Hertha & Lewis, 2020).

This paper describes the features of VWI and compares it with existing training methods. Case studies on different manufacturing operations (welding and assembly) are presented which show the benefits of this form of training on employee productivity and knowledge.

## 3. Background

Work instructions (WI) or standard operating procedures (SOP) are a set of instructions that enumerate all the steps and activities required to complete a job. WI and SOP define all the activities which will result in a satisfactory process or procedure. Typical WI and SOP are paper based and are written like a flowchart or algorithm. They include both written material and pictures to explain the steps to be followed for satisfactory completion of work. WI and SOP can be written for all functions within an organization, e.g., Machining a part on a lathe, repair, and maintenance of hoist, hiring an employee, quality inspection or ordering of a component from a vendor. They can range from simple instructions to overly complicated multi page documents and have been used in manufacturing industries for many decades. These documents are also used for training and cross training of employees in the organization.

Traditional WI or SOP suffer from many disadvantages. These documents are hard to control, difficult to understand in many situations, time consuming to create and maintain and do not capture the tacit knowledge of a trained employee effectively. In many situations they are not even used by employees on a day-to-day basis. Small manufacturing industries do not have the time or resources to create or update these documents regularly.

To overcome the challenges posed by regular SOP, a new way of creating them has gained traction in the last few years. In this approach, video of the manufacturing process is taken while the operation is being carried out. The video is later edited to include the work instruction in the frames during the actual operation. Safety and other important aspects of the operation can be noted while the video is played. There are several advantages to this approach such as:

1. Time Saving during the creating and execution of SOP
2. Easy to create and maintain
3. Accessible to all plant employees
4. Automatic Version control
5. Scalable to add, subtract or edit the operation as changes occur
6. Reduce training/cross training time
7. Improve quality and productivity

8. Capture the tacit knowledge of employees

## 4. Methodology

This study utilized both qualitative and quantitative approaches to review the existing training processes and methods (qualitative techniques), develop VWIs (qualitative technique), and comprehensively investigate the effectiveness (quantitative technique) of VWIs in optimizing task comprehension and execution within the manufacturing setting. The manufacturing facility where this study was conducted is a manufacturer of custom truck bodies in Southern Minnesota, USA. The manufacturing process of these bodies involves a series of steps from raw material procurement, laser cutting of sheets, bending operations, welding, and final assembly. The manufacturer has a variety of products – some ranging from standard medium – high volume, but most of the product portfolio involves high mix– low volume (HMLV).

In the first part of the study, existing training materials were reviewed which mostly included written instructions, unstructured SOPs, and process documents. These existing documents and ongoing training of new employees were observed and video-taped with the employer's and employee's verbal consent. During the review process of these documents and videos, inconsistencies in the trainer's training style and new employee's ability to get trained and retain the information delivered during the training were observed. It was also identified that the training differed a bit from person to person and process to process. During the information interviews after each observation, new employees provided feedback to somehow standardize the training process, but they did not know the VWIs would be the perfect solution to that need. Their feedback was mostly based around the person providing the training, if possible, the same person being the trainer each time for the same process would be helpful. They were also concerned about the inconsistency in the length of the training. All the gathered training materials and documents, video recordings of the training process, and outcomes from the interviews with the new employees after the training were sufficient proof to work on an alternative solution to what already existed in the organization.

In the second part of the study, a consensus was obtained from shop floor staff and management to develop and implement the VWIs for both Assembly and Welding Stations within the manufacturing plant. The process in developing the VWIs involved a structured and a systematic approach. To develop an effective VWI, a systematic and structure is key. The process involved identifying the tasks and steps deemed necessary by the process and understanding the audience's skill levels and familiarity with technology. After that, step by step script was created that breaks down the various tasks into clear and concise steps in an order. Visual elements were planned such as live-action footage, diagrams, and necessary text overlays to simplify and enhance the understanding of each step involved in the process. After that, production of the video content was performed making sure good lighting, clear audio and steady camera position was achieved. The video was later reviewed and edited to remove any errors, simplify, and enhance the clarity. It was made sure the video was easy to understand, follow and to the point. In any improvement efforts in any industry, manufacturing or service sector, testing is necessary sometimes called pilot study or trial-and-error. The video produced first, referred to as VWI, was reviewed with a small group of workers, subject matter experts in the area, and feedback was gathered for improvements. Based on the feedback, the content was iterated by refining the script, adjusting visuals, re-filming specific sections, and so forth. Real testing of the revised VWI took place with a new employee who had been recently hired and the employee was observed getting the training by following the VWI that had been produced. The same process was conducted for Assembly and Welding operations.

The third phase of the study involved quantitative analysis of the training time and the change in the productivity of the worker involved in the training utilizing VWI. Both "Before" and "After" metrics were documented in the form of time studies. Worker satisfaction was also gathered in the form of "positive" or "negative" feedback. All employees who went through the preliminary training using VWIs had more than 95% positive feedback. Improvements achieved through implementing VWIs in Assembly and Welding operations are discussed in the Results section of this paper.

It is also important to note that the development and implementation of VWIs is not a 'do it once and done' process. Continuous feedback from the employees and management was also key in developing the subsequent VWIs for the same operations and newer areas on the manufacturing shop floor. Continuously seeking ways to enhance the VWIs by reviewing feedback and staying updated on changes in processes or technology was noted to be a crucial factor in the sustainability of the newly implemented training process. Establishing a feedback mechanism to encourage workers to provide input and suggestions was another essential element of the newer process. Finally, measuring the impact of the VWIs on productivity, error rates, if any, and worker satisfaction by collecting data on task completion

times, accuracy, and confidence in using the instructions is a comprehensive approach which ensures that VWIs effectively improve task execution on the manufacturing shop floor.

## 5. Results

Quantitative analysis included a Two-Sample t-Test (assuming unequal variances) to analyze the effect of new training method on the new employees in terms of training hours with the new training methodology. There was a significant difference in previous training method measured in hours (M = 0.95, SD = 0.23) and new training method (M = 0.70, SD = 0.14) with t(df) = 23 and p-value <0.05. The findings for the Assembly Operations showed that the means of the training time were different and were statistically significant and there was 26.2% decrease in the total training time compared to the training without VWIs. The observed differences in the mean before and after the new training method for Assembly Operations are also shown in Figure 1.

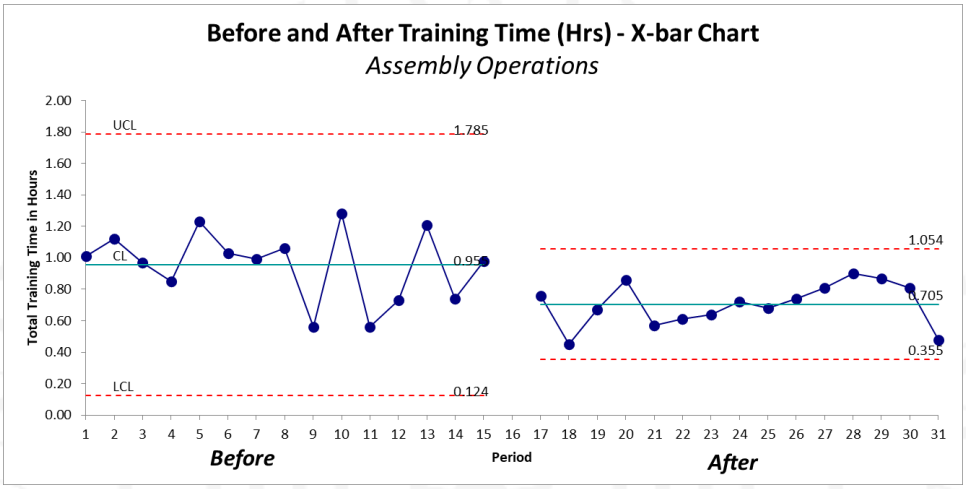


Figure 1. X-bar Chart showing the visual representation of the effect of new training method on Assembly Operations

Similarly, another Two-Sample t-Test (assuming unequal variances) was utilized to analyze the effect of new training method on the new employees measured in hours for Welding Operations. The findings suggested a similar outcome compared to Assembly Operations. There was a significant difference in previous training method measured in hours (M = 0.76, SD = 0.32) and new training method (M = 0.32, SD = 0.16) with t(df) = 20 and p-value <0.05. The findings for the Welding Operations showed that the means of the training time were different and were statistically significant and there was 50.3% decrease in the total training time compared to the training without VWIs. The observed differences in the mean before and after the new training method for Welding Operations are also shown in Figure 2.

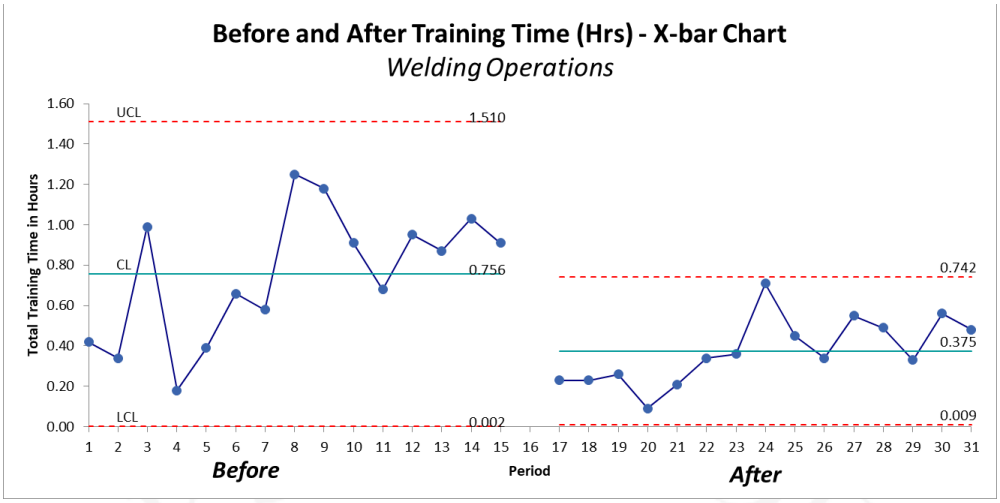


Figure 2. X-bar Chart showing the visual representation of the effect of new training method on Welding Operations

Another form of quantitative measurement of success for this study was obtained through the analysis of training hours in terms of productivity (%). Assembly Operations saw an average increase in productivity of 10.6% with the new training method while the Welding Operations saw an average increase in productivity of 13.7%. Individual data points showing productivity increase for each instance of training are shown in Figure 3 (a and b).

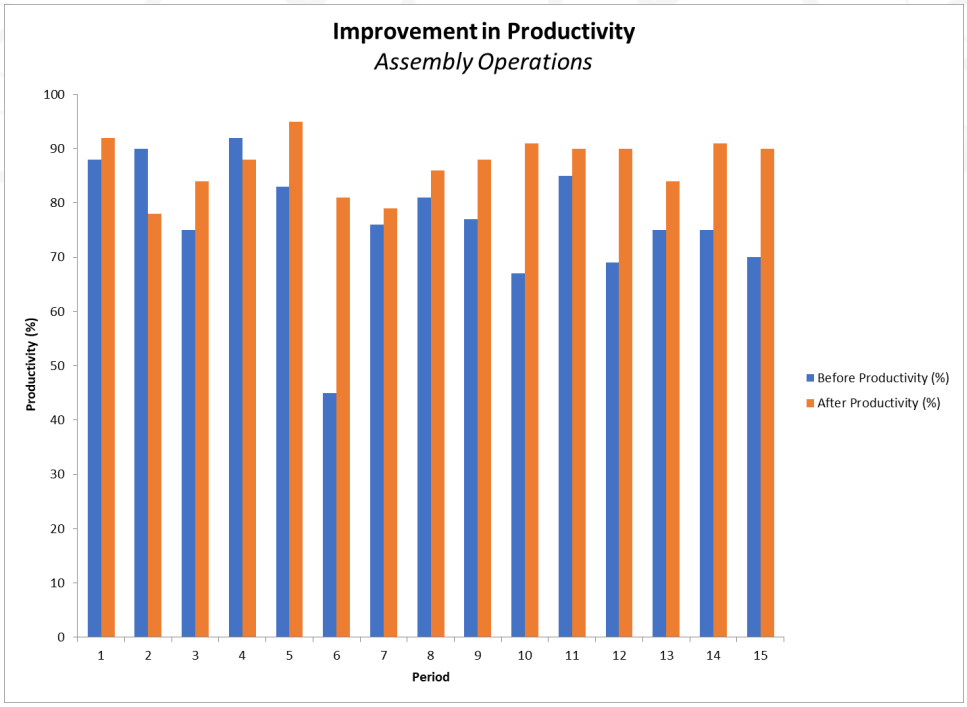


Figure 3a. Change in productivity after new training method was introduced (Assembly Operations)

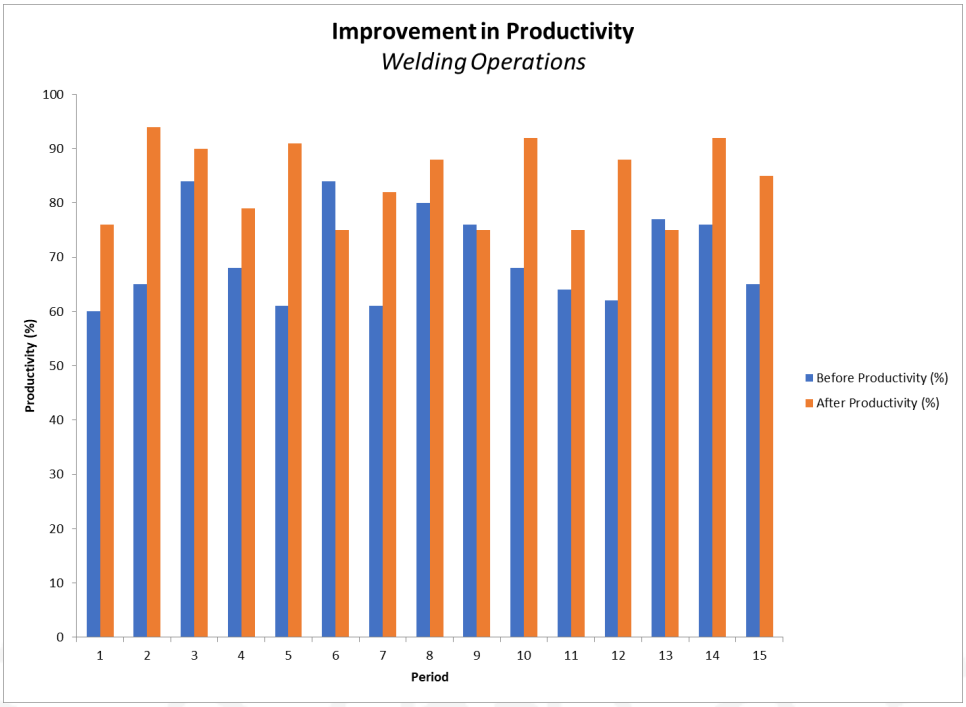


Figure 3b. Change in productivity after new training method was introduced (Welding Operations)

Overall findings of this study showed a positive outcome for the organization where the VWIs were implemented for manufacturing operations. Instead of it being a one-time event, this study took a form of an ongoing continual improvement where other areas in the manufacturing shop floor learned from early adopters of the new training methodology (VWI) and continued developing their own VWIs based on what worked based for their areas.

## 6. Discussion and Conclusion

The traditional form of written SOPs has outlived their usefulness on the modern shop floor. Today the shop floors have computer terminals attached to each machine and the operators and employees have access to tablets and smartphones which can be leveraged for better learning and analysis of operations. In these times, it is important to evolve the current practices of standard operations and introduce modern technologies which are easier to implement and use in day-to-day operations. Digitization in the training methods is showing a lot of demand in many sectors. For example, Bonnes et al. (2020) showed that trainers who attended a course in digital media had higher media-didactical competence and media-didactical self-efficacy scores and used digital media more often in training.

Key to the success of many companies in today's competitive economy is also the implementation of lean manufacturing principles which support standardization and use of advanced technologies to reduce waste and variations. Companies that have implemented lean manufacturing principles have also reported the knowledge-related issues as one of the barriers of success which goes back to simplified training methods (Abu et al., 2019). Stanica and Peydro (2016) also found that use of modern cross-training methods aligned as a lean tool has a positive effect on the knowledge transfer process within the organizations. Cross-training methods used as a lean tool can help broaden the knowledge and the competences of employees and can help companies manage tacit knowledge in the long run. How knowledge transfer is happening in an organization plays a key role in an organization's long-term success (Argote & Ingram, 2000). Not all lean organizations have achieved the expected results due to many issues such as cultural readiness of the organization, employee training, and continuous improvement techniques that are not compatible with the organization's preexisting processes, and programs. Sometimes organizations discount the benefit of training for a particular job or for a continuous improvement program in a smaller scale and simplified way such as using modern technologies such as VWIs. In other words, companies sometimes complicate the training method by overusing technology instead of simplifying it (Biortolotti, Boscari & Danese, 2015).

By converting the traditional methods of training based mostly on paper-based SOPs to video-based work instructions, a lot of issues which plague a shop floor can be elevated. In this study, the VWIs were used to train the employees on different operations and the effectiveness of this new technique was measured. VWI not only improves productivity but helps the employees be trained easier and faster. This technique is easier to implement and can be a source of continuous improvement for the plant.

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## Biographies

**Dr Kuldeep Agarwal** is a professor in the Department of Automotive and Manufacturing Engineering Technology at Minnesota State University Mankato. His research is in the areas of Additive manufacturing, metal forming, process improvements, and robotic welding. He is the graduate coordinator and works with local industries on lean, project manufacturing, and six sigma methodologies.

**Pawan Bhandari, Ph.D.** is an Assistant Professor in the Department of Manufacturing Engineering Technology at Minnesota State University, Mankato, USA. He earned a B.S. and M.S. in Manufacturing Engineering Technology from Minnesota State University, Mankato, USA, and Ph.D. in Technology Management (Quality Systems) from Indiana State University, USA. Prior to joining academia, he worked as a Principal Health Systems Engineer at Mayo Clinic, Rochester, Minnesota where he provided end-to-end consulting to internal clients between department, region, and enterprise level. He was also an instructor in the Health Care Systems Engineering, at the College of Medicine, Mayo Clinic. Prior to joining Mayo Clinic in 2013, he worked as a Manufacturing Engineer. He is also a professional member of the American Society for Quality (ASQ) and IEOM. He is also an ASQ Certified Six Sigma Black Belt and ASQ Certified Quality Improvement Associate. His research interests are quality and process improvement, technology management, quality systems, performance improvement in healthcare, and applied business analytics which includes but is not limited to machine learning, Artificial Intelligence, and data science.