Tero Kujala

CREATING WORK INSTRUCTIONS FOR PUNCHING MACHINE OPERATORS AT OJALA YHTYMÄ

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Thesis Abstract

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The main idea for this project was to create universal working instructions for punching machine operators at Ojala Yhtymä's factory in Sievi. Instructions needed to be simple and easy enough to understand so that it would even help new workers to get familiar with their work faster.

Everything started by gathering information at the factory and writing it down in as simple and understandable way as possible. Opinions from currently working operators were gathered multiple occasions so the content of the instructions took many forms before reaching the final version.

The effect of the produced working instructions could not yet bet measured because the best time to measure it would be in the beginning of summer when new workers enter the company. However some basic level predictions about the effect can be found in chapter 6.

Key words

Work instructions, Lean production, Just in time, 5 S, Kanban

ABSTRACT

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1. FOREWORD

This final thesis was done for Ojala Yhtymä in Sievi as part of a project which aimed to reduce setup times in production. It is a part of company's own continuous improvement which strives to make production more efficient. The writer of the thesis has worked in Ojala Yhtymä for one summer as punching machine operator.

The purpose of the thesis is to create a user friendly working instruction manual for punching machine operators and to clarify the most common problem situations as well as the use of the most common tools. A secondary objective for the working instructions was to present the information as simply as possible so it would help the new worker get familiar with his new job. Ultimately these objectives would aim to reduce the setup times of the punching machines.

The result of this work is a physical work instruction manual, which only concentrates on punching machines. Altogether 29 pages of work instructions were created both in Finnish and English. Because Ojala Yhtymä uses multiple types of punching machines, it was decided that the working instructions are done in universal form so that it would be valid despite the used machine type.

This final thesis consists of a theoretical and a practical part. First the theoretical part describes the methodologies and concepts connected to the subject. Then the practical part describes the procedures of making a new setup for punching machines with some of the additional information, which is needed to operate the punching machine.

I would like to thank my supervising teacher Markku Mäkitalo for support during the project and also Ojala Yhtymä's general manager Jari Linnala and production engineer Harri Häggman for cooperation and guidance.

2. ABOUT OJALA YHTYMÄ

Ojala yhtymä is a pioneer in sheet metal contract manufacturing in Northern Ostrobothnia, Sievi. Ojala Yhtymä has also factories in Krivan, Slovakia and in Chennai, India. There are also two sales offices located in Oulu and Helsinki. The company has been growing its roots firmly into the industry ever since 1963, but was known as Flextronic before 2006. The company has approximately 600 employees worldwidely and had a turnover of EUR €48,7 million at 2010.

The company's products are mainly pre-designed by customer but the company does have its own designs as well. The main focus in the production is on sheet metal and flat bar mechanics with punching- and bending machines. Various kinds or materials are used from hot-dip galvanized- and cold rolled steel to plastic with material thicknesses of 1-20 mm. Final products can also be surface-treated or powder-painted according to the customers wishes.

Ojala Yhtymä also provides assembling and system integration services. For example ready-made cabinets or modules containing all needed mechanics, electronics and cablings can be provided according to the customer's needs.

3. LEAN PRODUCTION

Lean is both philosophy and methodology that focuses on eliminating waste (non-value adding activities) and streamlining operations by closely coordinating all activities. Lean systems have three basic elements: They are demand driven, are focused on waste reduction, and have a culture that is dedicated to excellence and continuous improvement. (Stevenson 1993, 694.)

In short, lean thinking is lean because it provides a way to do more and more with less and less – less human effort, less equipment, less time, less space – while coming closer and closer to providing customer with exactly what they want. Lean thinking also provides a way to make work more satisfying by providing immediate feedback on effort to convert muda (waste) into value. And, in striking contrast with the recent craze for process reengineering, it provides a way to create new work rather than simply destroying jobs in the name of efficiency. (Womack & Jones 1996, 15.)

In the mid-1900s Japanese automobile manufacturer Toyota began developing lean manufacturing principles when its production was highly influenced with limited resources available at the time. Main idea with the principles was to remove all waste from every step of the production and every procedure which did not add any value to the produced automobile was counted as waste.

One of the eye-opening examples of lean operations potential was when lean methods were successfully adopted in auto plant at Fremont, California at 1980s. Previously operated by General Motors (GM), the plant had to be closed down due to low production rates. The plant was being reopened with some substantial changes in the production processes. From former plant worker only 80% were rehired, white-collar workers changes into supportive workers and small teams were created to implement continuous improvement. Productivity and quality improved by 1985 so dramatically that the plant surpassed all other GM plants. (Stevenson 1993, 694.)

3.1. Just In Time

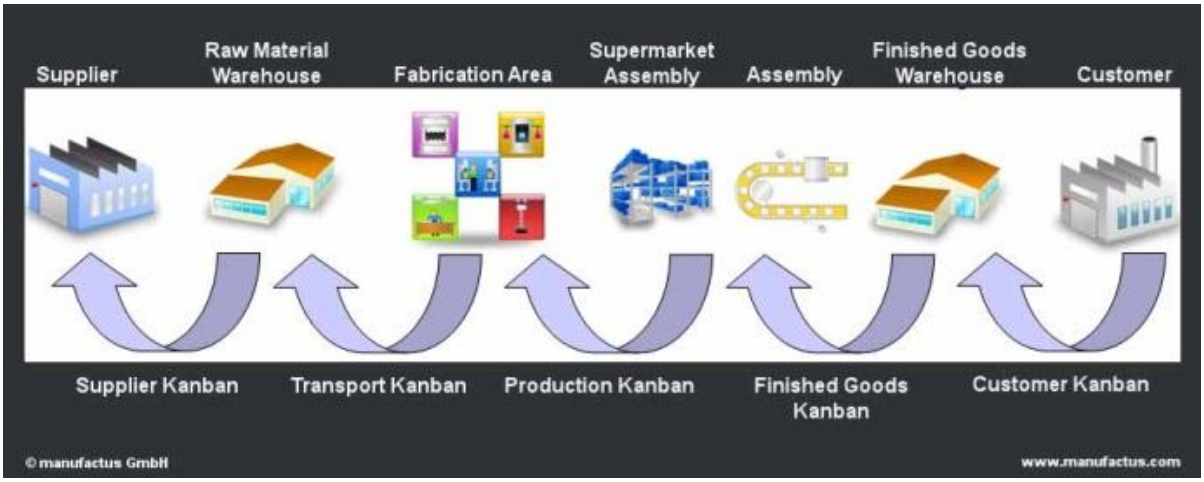
Lean systems are sometimes referred to as just-in-time (JIT) systems owing to their highly coordinated activities and delivery of goods that occur just as they are needed. The lean approach was pioneered by Toyota's founder, Taiichi Ohno, and Shigeo Shingo as a much faster and less costly way of producing automobiles. Following its success, today the lean approach is being applied in a wide range of manufacturing and service operations. (Stevenson 1993, 694.)

In ideal just-in-time operation services and sub-processes are performed just in time, when they are needed. For example in sub processes when material is needed, it arrives to the needed location exactly on time and no buffers are formed. This is the idea at which just-in-time aims, but in real life the processes can never achieve this ideal situation. However, the purpose of continuous improvement is to drive processes all the time closer to it.

Another major tenet in this philosophy is utilizing full capability of the workforce i.e., the workforce is made responsible for producing quality products/parts just-in-time to support the next production process. If they fail in meeting the responsibility, they are required to stop the production process (JIDOKAI) and can call for help. Additional responsibility is also given for improving the production process through participating in quality circles for process of production improvement. (Transweb global Inc. 2011)

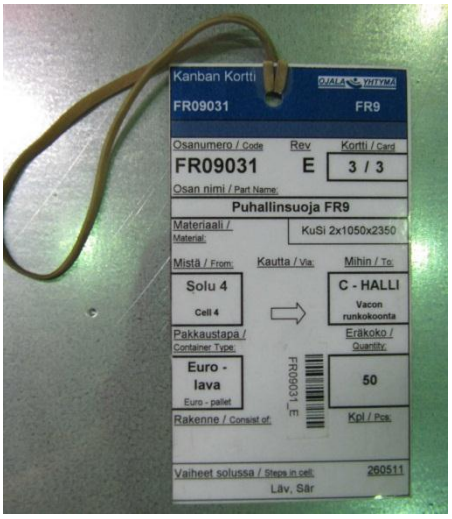
3.2. Kanban

Kanban is a manual system used for controlling the movement of parts and materials that respond to signal of a need (i.e., demand) for delivery of parts or materials. This applies both to delivery to factory and delivery to each workstation. The result is the delivery of steady stream of containers of parts throughout the workday. Each container holds a small supply of parts or materials. New containers are delivered to replace empty containers. (Stevenson 1993, 694.)



GRAPH 1. Kanban supply chain. (Manufactus 2012)

Kanban is a pull system where the material need of the next process defines the work flow. The given visual signal for a current need can be anything from a hand given signal to shouting or even blinking lights. One widely used method is a Kanban card-system where material is being stored in container and every contained has a Kanban card attached. When a worker needs to fetch more parts, he takes the whole container with a specific number of parts or materials and delivers the attached Kanban card to the place where the parts are produced. This way demand for the part creates an instant need for replenishment. The system can be tightened or loosened according to the situation by removing or adding more Kanban cards.



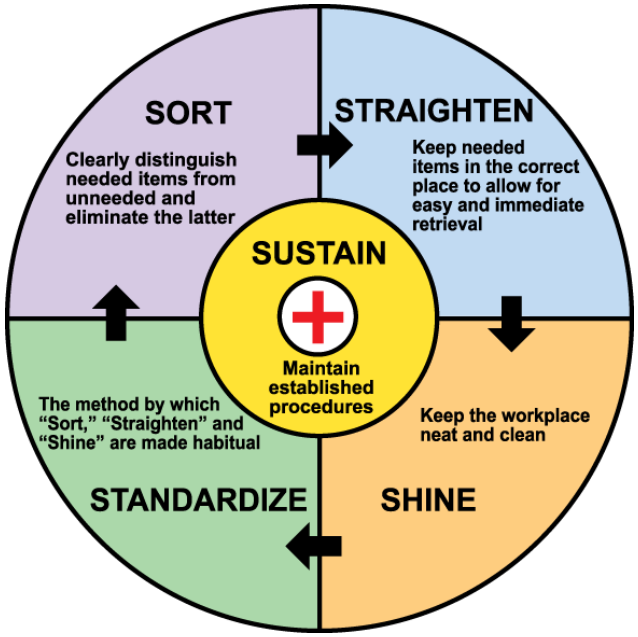
GRAPH 2. Ojala Yhtymä's Kanban card. (Tero Kujala 2012)

Kanban has also been implemented successfully in some of Ojala Yhtymä's cells by using Kanban board and Kanban cards. Whenever an assembling area is running low on certain parts, The Kanban card for corresponding part is sent to the production cell and placed into Kanban board. At the board, each product being produced in that cell has its own slot where the corresponding card is delivered. When punching machine operator chooses for a new order, he can see all the needed parts immediately. Each slot has multiple pockets for Kanban cards with three different colors. Green, yellow and red colors signal the urgency of order so by using simple color codes the machine operator can instantaneously see which orders are the most important to do.

GRAPH 3. Ojala Yhtymä's kanban board. (Tero Kujala 2012)

3.3. 5 S – Methodology

5 S is a methodology for organizing the workplace and it is one of the many tools of lean production, which aims at continuous improvement. In 5 S, the workers are included to the process of improvement and it can be extremely effective when implemented and supervised correctly.



GRAPH 4. Keys to sustain 5S. (Wrye 2011)

Basic idea is taught to workers in a simplified form which describes how to act in their everyday work and how following these procedures will eventually help themselves. Simple instructions from each 5 steps are presented with pictures to ensure that everybody understands them. Real life examples are presented with before- and after photos so that the result can be seen clearly. Importance of teamwork is to be emphasized, because integrated actions among workers results in an improved effect. (Ranta 2011)

3.3.1. Seiri

Seiri means organizing by getting rid of the unnecessary. This may include old files, forms, tools, or other materials that have not been used within the past 2 or 3 years. (Foster 2007, 89.)

Redundant objects may range from empty boxes through bins of rejected parts to obsolete machinery. Some objects might have some value but are simply inappropriate. Such is a jerry-rigged tool that substitutes for proper equipment repair. (Olofsson 2010)

The first phase (sort) concentrates on classifying all the items inside the working cell into categories of needed and unneeded so that all the unneeded items can be removed in the end. This can be done in several different ways but one way for example would be to set a time period, during which all the used items would be marked and at the end of the time period, all the unmarked items would be put in the category of unneeded items. In real life a couple of weeks' time period could be chosen and all the needed items could be highlighted with colored markers or post-it tags. All the unneeded items can be then either stored further away according to their usage or removed totally.

This phase has been implemented quite successfully in Ojala Yhtymä's work cells because no excessive items or tools can be seen lying around. Only the regularly needed tools are on the table and some special tools are stored in toolboxes, where they can be found easily if needed.

3.3.2. Seiton

The Second phase (set) is to create order for all the items that are left in the cell. Every item should have its own place in the cell and every item should be in its own place in the cell. Item places should be decided according to their use so that the item would be easy to retrieve and easily returned to its own place after use. If the amount of

items is considerably large, they could be put into categories and even marked with color coding in order to retrieve and return them faster. By using categories, significant reductions can be achieved in tool retrieval times and tool breakages which are resulted from wrong tool selections.

If everyone has quick access to an item or materials, work flow becomes efficient, and the worker becomes productive. The correct place, position, or holder for every tool, item, or material must be chosen carefully in relation to how the work will be performed and who will use them. Every single item must be allocated its own place for safekeeping, and each location must be labeled for easy identification of what it's for. (SiliconFarEast.com 2000)

In Ojala Yhtymä's work cells the effect of this phase can be seen clearly in tooling shelves of punching machines where all the punches and dies have been organized according to their shape and size. Every tool and die has its place and it doesn't take too long for a worker to locate the right tool even when it is surrounded by dozens of other similar tools. Also, all the other items in the cell have their own place and whenever needed they can be found without spending too much time for searching.

GRAPH 5. Ojala Yhtymä's toolin shelf. (Tero Kujala 2012)

3.3.3. Seiso

The third phase (shine) concentrates on cleanliness and safety in the workplace. All the areas and equipment which need periodic cleaning are listed and the responsibilities of those areas are assigned for individual workers. Usually a person working around the areas which needs to be cleaned should be assigned as responsible. Also the responsibility for equipment and machine cleaning should be assigned to workers using them the most.

At Ojala Yhtymä's factory new workers are taught from the beginning to follow all the set maintenance procedures. Workers are obligated to perform weekly machine maintenance on every machine and to report it through company's own ERP system. Weekly maintenance also includes the outlook of the cell so general level cleaning is performed at the same time. Floors and working surfaces are cleaned from excessive dirt and oil. Workers are also taught to clean any oil spills on floors whenever spotted for their own safety.

3.3.4. Seiketsu

Standardizing location for tools, files, equipment, and all other materials. This often involves color coding and labeling areas so that materials are always found in a standard location. (Foster 2007, 89.)

The employees can be involved in the development of these standardized rules because they have valuable information which they deal with on a day to day basis. In the end, everyone should know exactly what their job responsibilities are and they should know exactly how to perform them. (HubPages Inc. 2012)

Fourth phase (standardize) strives to make the three first phases into a standard routine. Steps are executed and supervised correctly and workers are taught to follow these routines in their daily work. Involvement of management side is crucial so that the new procedures are executed correctly from the beginning. Responsible personnel

needs to be assigned, level of cleanliness and order needs to be determined and scheduled for cleaning and check-ups need to be agreed upon.

Implementation of this phase can be seen clearly in Ojala Yhtymä's work cells, when all the tool markings are done exactly in the same way. Punching machine setup boards contain crucial information about all the used tools, so when different people work at the same machine, everybody needs to be able to read those markings. Also whenever starting a new order, the paper work is always the same regardless of the work cell. Production order forms as well as all other used forms are standardized so that standard procedures can be maintained in the whole factory.

3.3.5. Shitsuke

The last phase (sustain/discipline) aims to maintain the new procedures so that they become a daily habit. Extremely clear instructions of new procedures need to be given for each work cell so that they can be reviewed again whenever needed and understood even by a new worker starting his first day. Also a system needs to be created ensuring that all the needed tasks are done periodically. A simple cell-based checklist can work well enough to ensure that the new procedures are followed. The management needs to set a reasonable time-interval between the check-ups and monitor them so that necessary adjustment can be made if needed.

Managers are particularly important in instilling discipline into the workforce. They can insist that discipline is used. They can schedule reviews and even check that the reviews are effective. They can also empower their subordinates giving them the authority to decide, for example to shut down a production line when a problem threatens product quality. Discipline can involve difficult decisions. Culture of punishment will encourage risk-averse behavior and lack of facing reality in a disciplined way, no matter how uncomfortable the situation is. (Syque 2011)

At Ojala Yhtymä, supervisors in each shift make regular checkups so that the weekly maintenances are being performed correctly. Every now and then more extensive cleanups are being performed throughout the whole factory. These comprehensive cleanings are held on times when the amount of orders is considerably low and one whole day is devoted only for maintenance and cleaning.

4. CREATING THE WORKING INSTRUCTIONS

4.1. Introduction

The idea for the thesis was formed during a summer job in 2011 and by contacting the general manager Jari Linnala the topic was discussed more closely. Fortunately a project was being started concerning setup time reduction on punching machines and my topic was formed so that it could be connected to this same project. The basic guidelines had already been agreed for the topic but it was the first meeting between general manager, me and my supervising teacher Markku Mäkitalo, which determined the final course of the thesis. It was agreed that working instructions should be made in such a way that they would be universal enough to be used in every punching machine despite the regardless of type.

4.2. Starting situation

Currently new workers are introduced to their jobs by tutor workers, who teach them all the needed working procedures they need to know in his/hers job. Every new worker gets one individually assigned tutor worker who observes their job until they can be trusted to work alone. Depending on tutor workers and complexity of taught jobs, some new workers need to be tended longer than other, especially when training a new punching machine operator. When new workers are left to work alone, they still face new problems daily and need to return to their tutor or neighbor cell machine operator for advice. The only way for them to solve problems is by asking from other workers.

4.3. Purpose of the project

The outcome of this whole project was to serve two purposes. First of all it would standardize the work phases and procedures in order to take step towards more efficient production and better quality. Second purpose would be to help new workers to learn the working procedures faster so that they could start working sooner without the guidance of tutor worker. Whenever a tutor worker is needed for guidance, productivity of two workers is lowered significantly so it is according to company's own interest to lower these idle times. Every time when a new worker can find answer to his problem from the instructions, time will be saved and that is what this project aims at.

By achieving one of these goals or possible even both considerable amount of time would be saved. Standardized working instructions would clarify all the steps of making a new machine setup and reduce overall setup times made by new workers as well as old workers. When new workers are introduced to their new jobs by tutor worker, it could take from one to four weeks until the new worker can be left work alone without the guidance of his tutor, so during this time one experienced worker is idle from the production viewpoint. If the produced working instructions would be able to reduce the needed guidance time even just a little, this work could definitely be considered successful. Even if the setup- and guidance times would be reduced by hours or minutes it still has considerably large effect when considering long-term savings. Also the fact that if every summer at least ten new summer workers enter the company, together they may accumulate surprisingly large amount of saved time.

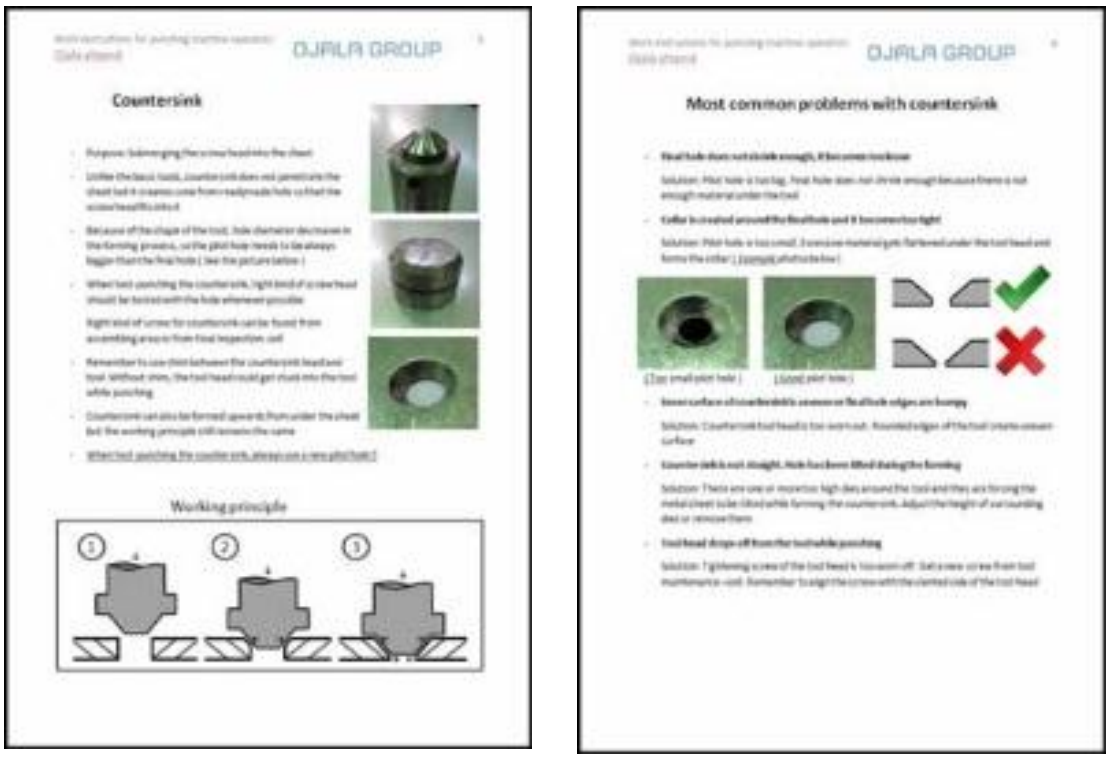
4.4. Creating process

The whole work started by collecting ideas from punching machine operators at Ojala Yhtymä factory in Sievi. Currently working operators were interviewed and asked to tell what were the most difficult things to learn when they started the job, what kind of problems they faced and what they would do differently. Together with these ideas and my own pre-made plans, a basis was created for the instructions by dividing the

working instructions into three different entities: technical data, work instructions and problem situations.

The technical data- section consists of all the necessary data charts which are needed in everyday work. In addition all the data which is used rarely or not even at all needed to be removed because it would only create more confusion for new worker. When a new worker starts to learn his new job, he is surrounded daily by new information and it is impossible for him to determine which data is relevant and which is not. Only through experience can workers tell apart necessary and unnecessary data, so for this reason currently working machine operators opinions were so important. With their help, irrelevant data which would only cause more confusion and delay the process of learning the new job could be removed.

This section also provides critical information concerning most used forming tools, so that when new a worker has not used a specific tool before, he will be able to learn the use without guidance of tutor worker. And even if the tool would have been used before, the worker is likely to face some basic level problems with that specific tool so some level of troubleshooting would also be required. In the process of choosing which tools to describe in this section, working operators were asked which tools they considered to be most used. As a result of this, four basic forming tools were chosen to be taken under closer look. For all these tools one page was used for providing the critical user information and another page was used just to provide solutions for most frequent problem situations. Even if the user would know how to use some specific tool correctly, he could face unexpected problems which he does not know how to solve. For these situation the troubleshoot page would provide an answer and possibly save more valuable production time.



GRAPH 6. Page examples of work instructions created in thesis work (Ojala Yhtymä 2011)

The main purpose of the work instructions- section is to standardize the working procedures when making a new setup for the machine. When multiple tutor workers have been used to teach the machine operating for new workers, it is highly likely that their methods of teaching differentiate at least a little and so the working procedures may not be exactly the same. For this reason it was seen necessary to produce documented working instructions so that the working procedures could be unified and standardized. Every step in making of a new setup was defined and with the help of general manager and production engineer they were made universal for all the machines types. Because this work as a whole was a part of a project which aimed to reduce the setup times, the same aspect of setup time reduction was needed to be implemented in this section too. This was done through set of actions which were preparing the setup of the next work while the machine was still running. These anticipatory actions were highlighted visually in the working instruction in order to emphasize their importance.

The final part of the work instructions was the problem situations –section. The main idea was to list the most common problem situations which any punching machine operator could face during his/hers work and then provide solutions for solving them. For this section, opinions of currently working operators were asked and the list of problems became unexpectedly large. With the help of the management side workers and most experienced machine operators, the most relevant problems were chosen and multiple solutions for them described. As a result the big variety of problem solutions should provide additional solving methods even for the more experienced worker.

The basic idea from the beginning was to create a simple and visually entertaining outlook without too deep unnecessary technical information so that a new worker could understand what he was reading. For example in the technical data- section most used tools would be described with pictures and text so that immediately when opening a page on a specific tool, the reader would see pictures of the tool, the corresponding die and result of a correctly formed hole. By presenting the made work frequently for machine operators and management personnel, crucial feedback was received, which allowed editing the outlook so that it would suit their need better.

The work was also presented frequently to general manager of the factory who also gave feedback and made suggestions on additional content which should be added to the work. In the end two additional pages were added to make the instructions more informative for new workers: general safety precautions and punching rotation pictures. At this point there was enough content for the work but the biggest task was to present it as clearly as possible, so the work kept changing all the time when new feedback and suggestions kept pouring in. Finally, after several changes in the outlook were made, the final form was created and approved by all participants.

GRAPH 7. Page examples of work instructions created in thesis work (Ojala Yhtymä 2011)

A table of content was created for the work instructions so that it could be used as a quick checklist for making the new setup. By using this step by step -checklist, the chance of forgetting one of the steps is lowered significantly and at the same time, it standardizes the setup making process. Yellow signs were placed to mark which of the steps anticipate the next upcoming setup so that it could be already partially prepared for. The visual outlook needed to be pleasant for eyes and easy to read so the right balance between text and pictures had to be chosen.

GRAPH 8. Physical outlook of the work instruction folder (Tero Kujala 2012)

When the physical outlook of the working instructions was being considered, a couple of variations were made with different level of durability and upgradeability. At the end a presentation folder with durable plastic covers was chosen because of the fact that pages could be added and edited later on. This solution makes it easy to create further version from the working instructions without further investment in the covers.

It was chosen for the working instruction folder to be located in every cell near the computers which are being used daily for inputting information into ERP-system. A worker spends the most time during the workday around this area, so it is highly likely that worker will read it through while waiting for punching process to finish.

GRAPH 9. Placement of the work instructions at cells (Tero Kujala 2012)

5. THE EFFECT OF PRODUCED WORKING INSTRUCTIONS

Because the working instructions were created around Christmas, there were no new workers entering the company at the time so the effect of them could not be monitored yet. Of course the working instructions can also have effect on currently working machine operators working procedures, but the best result can be seen when new workers are entering company and can read the instructions for the first time. The best time to monitor the effect would be in the beginning of summer when multiple workers are starting to learn machine use. The company already has statistical information about how new summer workers learn their job and they can compare it with upcoming data next summer.

Because the effect of newly produced working instructions cannot be seen yet, a forecast can be made based on expected effects. When a new worker spends his first weeks working with the guidance of a tutor worker, he receives a lot of new information which he cannot totally comprehend. He might know how a procedure is done, but he might not understand the reasons behind it. Some of these procedures are explained clearly in the working instructions so it can be expected that after reading the instructions, the worker will understand better why he is doing some task and through this solve problems connected to it better.

For example when facing a problem while making a new machine setup, a new worker could be able to solve it without the help or his tutor worker, and through that remember it better in future. This would help the worker learn his new job faster and thereby reduce the time needed for tutor worker to watch over him. Overall quality of the products is lowered for a while when new workers are working on their own and cannot necessarily spot all the defected products and this results in a loss of time and material because the parts need to be redone from the beginning.

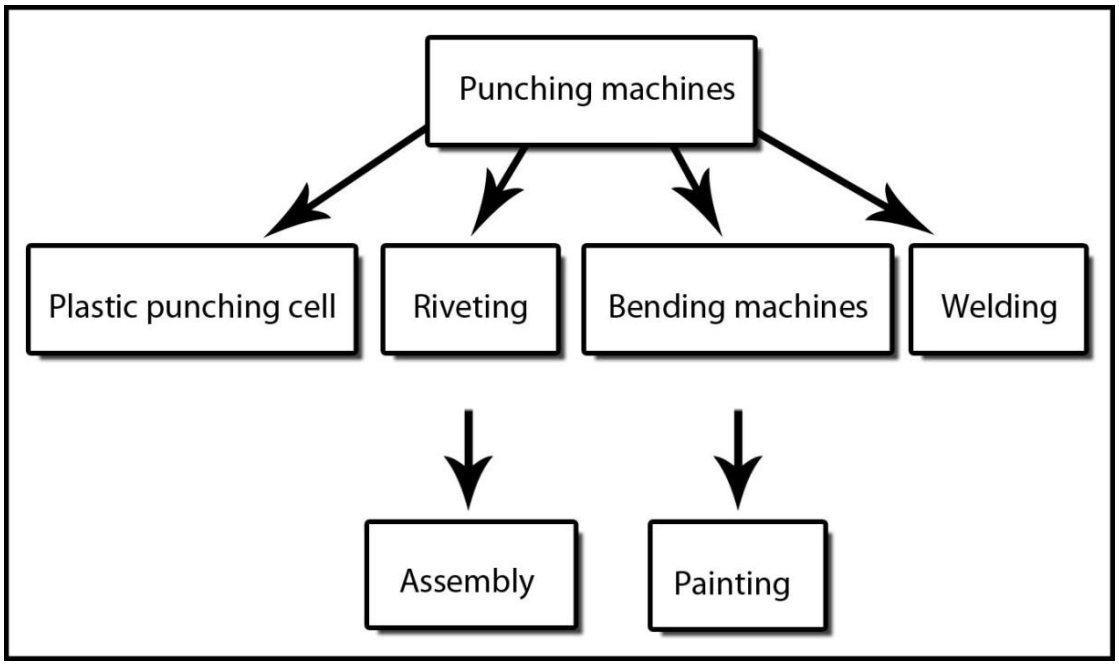
After reading the working instructions, new workers should possess better knowledge of the defects in products and procedures of how to avoid causing them. When

multiple new workers all have this same information in their hands, it is very likely that some of them remember it and can react in the right way when seeing a defected product or possibly even avoid it so this effect of the working instructions could result in savings in material usage, savings in working time and improvement in overall quality.

One new worker had entered the company before the work instruction –project had ended and fortunately this worker was assigned to be a punching machine operator. So during the last days of the project, this worker was interviewed for his opinions about the manual. The Interview showed some quite positive results because it seemed that this worker had taken this manual as a part of his daily work and according his own words, had read it through multiple times. So if the work instruction provides information that can keep the reader interested enough to read it multiple times, then it certainly can be considered successful.

6. RECOMMENDATIONS

If the working instructions have the expected effect of reducing the setup times and learning time of new worker, then the next logical step would be to extend the instructions to other machines and work phases as well. Bending machines would probably be the best choice to start from considering that they share similar complexity of working procedures. All other production phase machines should also be taken under consideration as well when choosing where to extend the working instructions in future. If the working instructions prove to be useful in multiple production phase machines then a possibility of extending the instructions into painting and assembly should also be given a careful though.

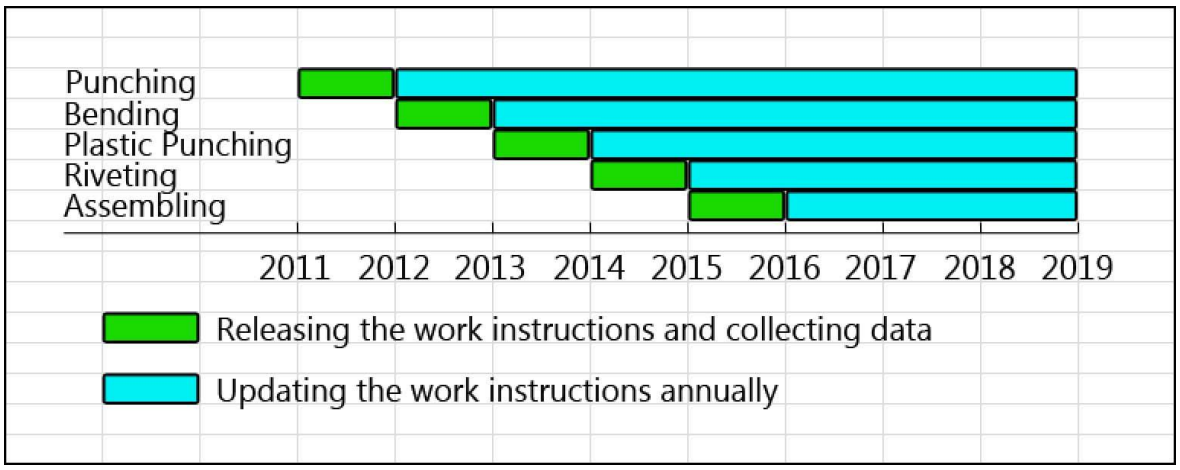


GRAPH 10. Extending possibilities of work instructions (Tero Kujala 2012)

During the summer time, the need of new workers is highest because of the summer vacations held by permanent workers. This time is also the best time to test the work instructions for other work phases as well. This then creates a minimum time interval of one year, during which new instructions need to be tested before proceeding into releasing a new one. However updating previously released instructions should not be

forgotten and this can be done by collecting honest feedback from new users and monitoring the setup times through ERP. Updating released work instructions should also be considered as continuous improvement, and the results of their impact should not be expected to be at their highest after the first released version. The amount of effort put into creating the instructions should be equal to the amount of effort put into keeping them updated.

Importance of keeping official document updated is as important as doing scheduled maintenances for machines under everyday use. The Only difference is that updating an electronic document can be a lot quicker, easier and less expensive. Without updating documents at regular basis, the containing information can become inaccurate over time, which therefore turns the document slowly into waste (Kaizen) and over time it can become incorrect enough so that it has to be removed. With little effort, the document can be sustained and even improved through time.



GRAPH 11. Extending schedule of work instructions (Tero Kujala 2012)

Another way to proceed would be to keep upgrading the newly made instructions even further by adding more special tool-pages and listing problems situations in them. By monitoring the effect of instructions and collecting workers opinions and improvement suggestions, some completely new ideas could surface.

If it turns out that the effect of working instructions is positive and if the company sees it fitting to implement the same instructions also to other work phases as well, then

the next fitting step could be to standardize it. By creating a standardized form for all the working instructions the efficiency would increase and making of other instructions in future would be easier as well.

In order to develop the work instructions even further in the future, opinions need to be gathered from new worker after they have learned their new jobs. Their ideas of possible improvements for the instructions can be totally different than the ideas from workers who did not have instructions available when learning their jobs.

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8. Appendix

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