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## **Thick Turret Tool Guidelines**

Thesis

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Automation Engineering



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## **Thesis abstract**

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The purpose of this thesis was to create a thick turret tool-guide for the customers and new employees of Prima Power who work with the Prima Power turret punch presses.

Prima Power has customers all around the world, and from time to time the thick turret tools in sheet metal machinery are misused by the customer operators. Because of these actions the tools wear off quicker, complete manufacturing lines may stop as a result of tool fault alarms or the tools get damaged into an unrepairable state.

The primary objective was to make a clear guide for the tooling of the turret punch presses, so the employees of Prima Power and the customer operators know how to use the thick turret tools correctly. Feedback on the guide will be gathered from the new users of the punch press turrets and also from experienced users.

Keywords: turret punch press, thick turret tool, guide, sheet metal

SEINÄJOEN AMMATTIKORKEAKOULU

## Opinnäytetyön tiivistelmä

Koulutusyksikkö: Tekniikan yksikkö

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Työn tarkoituksena oli tuottaa ohutlevytyökalu ohje Prima Powerin asiakkaille ja yrityksen uusille työntekijöille, jotka toimivat ohutlevytyökeskusten parissa. Prima Powerilla on asiakkaita ympäri maailmaa ja välillä ohutlevytyökeskusten työkalujen oikeinkäyttö operaattoreilla on puutteellista. Tällöin työkalut kuluvat nopeammin, kokonaiset tuotantolinjat pysähtyvät työkaluvirheilmoitusten takia tai työkalut vaurioituvat korjauskelvottomiksi.

Tavoitteena oli tehdä selkeä ohje, jotta yrityksen työntekijät ja asiakkaan operaattorit ymmärtäisivät miten työkaluja käytetään oikein. Näin voidaan välttää vikatilanteet ja koneiden käytöstä tulee sujuvampaa. Ohjeesta kerätään palautetta uusilta ja myös kokeneemmilta käyttäjiltä.

Avainsanat: ohutlevytyökeskus, työkalu, ohje, ohutlevy

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## Terms and Abbreviations

<b>ERP</b>	Gathers order data and is used to send production orders to the manufacturing units.
<b>G-code</b>	Commands CNC machines which action to take.
<b>Greenshot</b>	Screen capturing software.
<b>Multi-tool</b>	Turret punch press tool that includes more than one punching tool.
<b>Ram</b>	Component of the turret punch press that presses the thick turret tool downwards to punch through or form a metal sheet.
<b>RMA</b>	Receiving refunds, replacements or repairing a product after it has been returned during its warranty period.
<b>Slug</b>	Small scrap piece from sheet metal when the sheet has been punched with a single punch stroke.
<b>Tool station</b>	Station for the thick turret tool. Includes a holder for the upper tool and a die.
<b>Thick turret tool</b>	Turret punch press tool (also known as tool).
<b>Turret</b>	Rotating part in the middle of the machine frame where the thick turret tools are placed.

# 1 INTRODUCTION

Prima Power manufactures and sells sheet metal machines and systems all around the world. The machine is first assembled and tested at a Prima Power factory. Then the customer checks that the machine meets the requirements, and finally the machine is shipped to the customer facility where the on-site operations start.

The on-site operations on customer facilities include the installation, start-up and training phases. For all these phases, Prima Power personnel is needed, but the training part is the only one that the customer can prepare themselves beforehand.

There have been some cases in the on-site operations where the thick turret tools have been damaged to an unfixable state by the inexperienced operators of the Prima Power sheet metal machinery. In the year 2017 the customer trainers of Prima Power we're asking for a clear guide for the customer operators and programmers as well as for the new employees of Prima Power, on how to use the thick turret tooling correctly.

## 1.1 Objective of the thesis

This thesis will be a part of Prima Power Academy, a Moodle based environment, as one of the introduction courses for the new employees and also for the customer operators working with turret punch presses. The goal of this guide is to smoothen the training of turret punch press tooling in on-site operations. It is most important to have a very clear guide for countries where the personnel of the customer doesn't speak fluent English or does not understand it at all and thus has to use translators.

This way customers can get their production units working faster not having to train the personnel so long which means saving time and money. Prima Power, on the other hand, will have more resources available for other projects as the machines do not need to be fixed because of the misuse of thick turret tooling. This will also reduce the need for extra training.



## **1.2 Structure of the thesis**

The thesis is started with an introduction consisting of the background-, objective- and structure of the thesis. Also at the end of the first chapter there is a company presentation. Sheet metal fabrication is covered in the second chapter. There is information about sheet metal fabrication, sheet metal machinery and the controlling of the machines. The third chapter is about the thick turret tools and the three different methods of using them. CAM in general and Prima Power CAM, NC Express e<sup>3</sup>, are introduced in the fourth chapter. The purpose, advantages and benefits of the guide and its material are dealt with in chapter five. The guide project itself is introduced in chapter six. The benefits, future applications and a summary are gone through in chapter seven.

## **1.3 Company presentation**

This chapter is divided into two sections because the actual company this thesis is written for is a part of a more massive corporation. Prima Power is the name of the corporation, and Finn-Power Oy is a turret punch press machinery division of Prima Power.

### **1.3.1 Prima Power**

Prima Power is a global manufacturer of sheet metal working machines and systems. Prima Power is a part of Prima Industrie S.p.A. Their manufacturing facilities are located in Italy, Finland, USA, and China. There are sales and service activities in over 80 countries. Prima Power ships the machines and systems produced in all these facilities to customer factories, installs the machines, trains the customers, and also helps the customers to get an easy start with the production. (Prima Power [Ref 21.11.2018].)

### 1.3.2 Finn-Power Oy

Jorma Lillbacka founded his engineering workshop in 1969. The brand of the Lillbacka engineering workshop was Finn-Power which later became the name of the company. (Seppälä 2008.)

The first own products Finn-Power made were hydraulic crimping machines that were first sold in 1973. The crimping machines also needed sheet metal parts as components. An idea to invest in a turret punch press was born in October 1982. Quotations for turret punch presses came from German Trumpf, American Strippit and Japanese Amada. But all these machines were too big and too expensive. A smaller and more affordable self-made turret punch press would have been ideal for Finn-Powers own production and it was also seen as a possible export product. That is where the journey of Finn-Power as a sheet metal machinery manufacturer started. In June 1983 the first Finn-Power hydraulic turret punch press, TP-250, was introduced at CECIMO convention in Paris. After ten years from the launch of TP-250 the sales of the Finn-Power sheet metal machinery had grown to 217,6 million Finnish marks. To get the right perspective of the growth this can be compared to the Finn-Power crimping machine sales that were 36,3 million Finnish marks at that time. (Finn-Power 2019, 15-43.)

In 2002 Lillbacka sold his company to the EQT-equity fund. While owned by EQT, Finn-Power sales increased from 136 million to 240 million euros. In 2008 EQT sold the company onwards to Prima Industrie S.p.A. (EQT 2008.)

Finn-Power Oy moved their production facility from Kauhava to the Roves industrial estate in Seinäjoki during 2018. The facility is located near the new eastern bypass. The new facility is 20 000 square meters large including a new factory and offices. (Hantula 2017.)

## **2 SHEET METAL FABRICATION**

A manufacturing process where a sheet of metal is shaped into a part by material detachment or reshaping material is classified as sheet metal fabrication. A sheet of metal, which acts as the starting piece for these processes, is the form that is most commonly used as raw material stock. The sheet thickness which is classified as a metal sheet for this process, is not defined explicitly. Usually, the sheet thickness that classifies as sheet metal is between 0.15 and 6.35 millimetres. (Custompartnet [Ref. 29.1.2019].)

### **2.1 Methods of sheet metal fabrication**

Forming and cutting are the two categories into which sheet metal fabrication can be divided. A process where force is applied to the material to make it deform is called a forming process. This kind of operations are used to get a wanted shape by bending or stretching the sheet. When the part of the sheet where force is applied detaches from the sheet itself, it is a cutting process. Most cutting processes are also known as shearing processes. In a shearing process, a big enough shearing force is applied to the material to separate it. Rather than using shearing force, heat and abrasion are used in other cutting processes to remove material. (Custompartnet [Ref. 29.1.2019].) Cutting and forming operations with thick turret tools are explained in chapter 3.

### **2.2 Turret punch press**

Also known as a CNC punch press, the turret punch press is the more economical choice compared to a dedicated stamping press because it is continuously developed to be faster and more diverse. The operations of all turret punch presses are similar. The sheet of metal is held by the edges by workholders and moved on the table to get it to the right position between the lower and upper turret. The precision motions of the sheet on the table are made with two lead screws: one

controls the transition in the X direction and the other one in the Y direction. At the same time the turret rotates the correct tool into position. (Make it Metal 1995.)

Turret consists of two components: the upper- and the lower turret. The assemblies of the thick turret tools are placed in holders in the upper turret, and the dies are placed in the holders in the lower turret. The sheet can be punched with one stroke or several strokes next to each other, which is called nibbling. (Prima Power 2017b.)

Switching from manual machinery to a turret punch press multiplies the productivity. Also, the need to transfer parts from one place to another inside the factory might decrease because several operations can be centralised to the turret punch press. (Aaltonen, Andersson & Kauppinen 1997, 38.)

Because of the many possibilities for automatization the turret punch press is an essential component in sheet metal fabrication. It can be connected with ease to an automated storage system so that the FMS-level automatization can be achieved. (Aaltonen, Andersson & Kauppinen 1997, 42.)

Turret punch presses are numerically controlled. The saving of a completed program for possible reuse or modifying is very easy from the programming point of view, and that is the advantage of the turret punch press when compared to a dedicated stamping press. (Aaltonen, Andersson & Kauppinen 1997, 42.)

### **2.3 CNC**

CNC is the short abbreviation for Computer Numerical Control which can be understood as controlling a machine via numerical values fed into it. The input of the technical information of these values is an input media like hard disk, USB flash drive or RAM card, et cetera. The machine follows the given sequence of operations it has to execute at the given speeds to produce a piece that is correct in shape and size. (Inno Creative 2009, 1.)

Machine processes the data programmes fed into it by the input device and executes them, see figure 1. Movement and functions of the machine can be seen from the display unit.

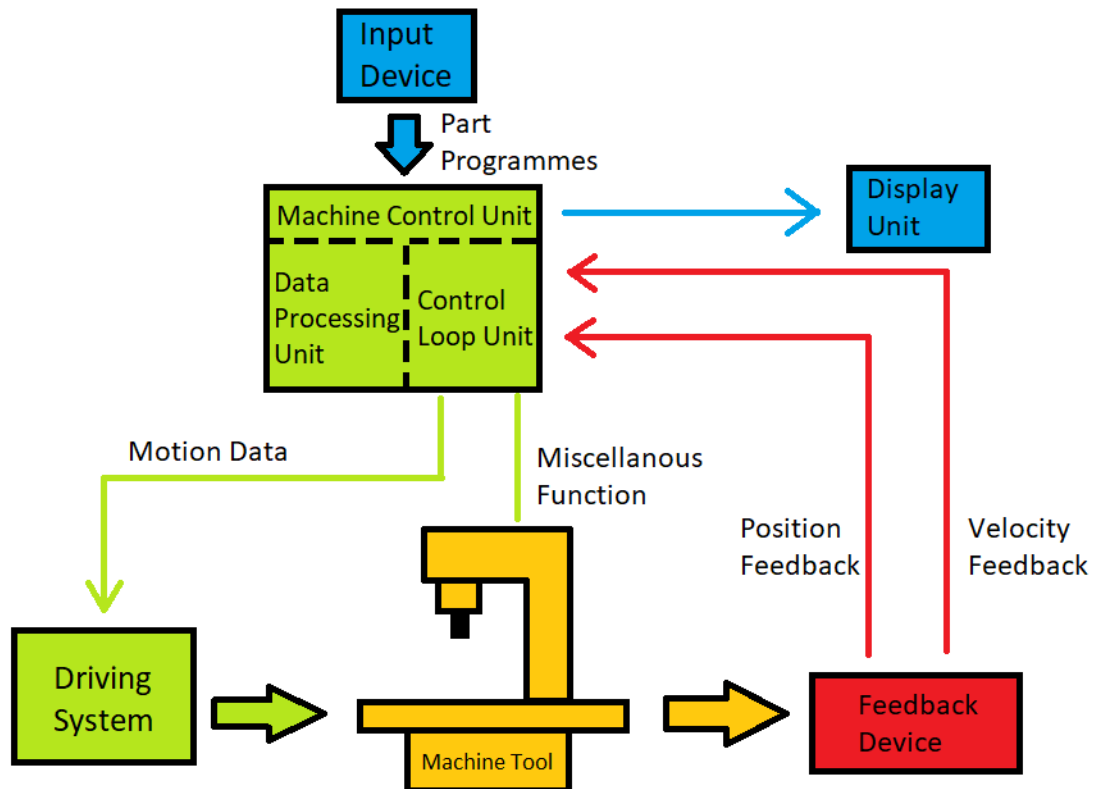


Figure 1. Working principles of CNC Machines (Inno Creative 2009, 4).

Sometimes a program that is used before can be used again. If a product has to deviate from the original program, it can be generated through reprogramming, and after that a program for a production order which has modified products is ready. (Inno Creative 2009, 1).

## 2.4 Punch Genius

Punch Genius is the latest Prima Power turret punch press, see figure 2. It has servo-electric axes that are numerically controlled, have high energy efficiency, are operationally fast and low in demand for maintenance. (Prima Power 2016a).

Punch Genius has three linearly moving axes X, Y and Z movements. The coordinate table moves in X- and Y-directions, while holding the sheet with clamps and the Z (vertical) punching stroke is created with a servo-driven-mechanism. On top of the linear movements, it has two rotating axes (0 – 360

degrees): an index-axis for individual tool rotation and a turret-axis for tool station changes. (Prima Power 2017b.)



Figure 2. Prima Power Punch Genius-turret punch press (Prima Power 2016b).

Punch Genius turret where the thick turret tools can be placed has 16 or 20 stations for the thick turret tools. Some of the stations are indexable meaning that they can be rotated individually. This way, for example, a rectangular punching tool can be used to punch a rectangular hole in any angle or a roll forming tool to make curved shapes. (Prima Power 2017b.)

## 2.5 Tulus® Cell

Tulus® Cell is the graphical user interface of Prima Power sheet metal machinery. It is used to manage the machine tasks for one machine or the entire factory. Also, it controls the production orders if the operator wants to add, remove or change them. All of the information on the machine-related tasks can be seen in the task list. If something is modified in the task list that affects working orders, the interface will notify the user of the changed production schedule, tool- and material information as well as the delivery times of the parts. (Prima Power 2013.)

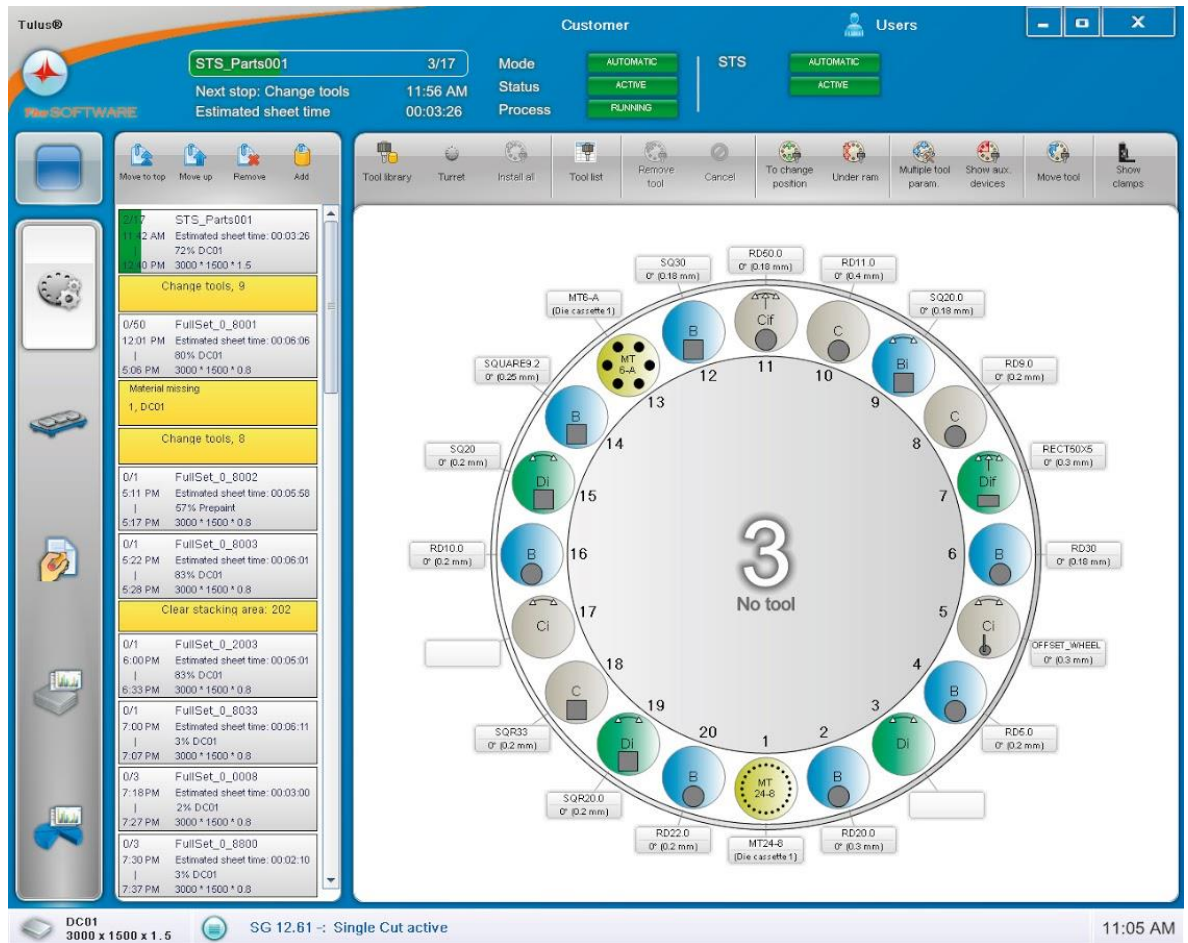


Figure 3. Tulus® Cell graphical user interface (Prima Power 2016c).

Tulus® Cell is the graphical user interface used by the machine operator. Tulus® Cell is user friendly, modern and is easy to learn for an experienced operator of sheet metal machinery. The task list of production orders, tools installed to the turret and different functions button are easily accessible for the operator, see figure 3.

### **3 THICK TURRET TOOLING**

Thick turret tools are used in turret punch presses and have a high impact on how fast the machine can be operated. There is five different sizes of thick turret tools A, B, C, D and E. A is the smallest and in size order alphabetically continuing to E which is the biggest. New thick turret tools come out to the market every year. The manufacturers of the thick turret tooling are continuously developing their tooling to be more diverse, durable and effective.

#### **3.1 Basics**

Thick turret tools can be divided into three groups by the purpose they are used for: punching tools, forming tools and roll forming tools (Prima Power [Ref. 9.2.2019]). A thick turret tool is comprised of the tool assembly and the die. For example, the tool assembly of a punching tool consists of a spring-loaded canister, a punch guide, a punch and a stripper plate, see figure 4. The spring loaded canister lifts the punch back up again from the sheet after punching. Punch guide makes the punches accurate by guiding the punch to the sheet and the stripper plate functions as a separator, so the punch does not get stuck to the sheet.



Complete assembly

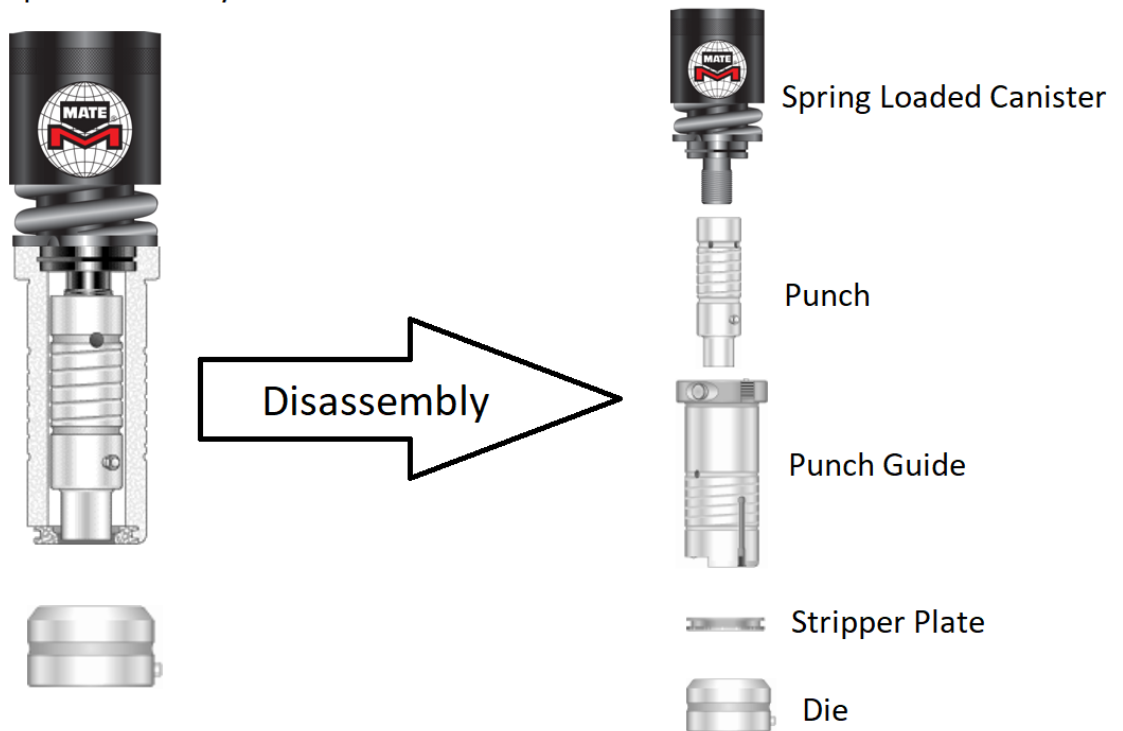


Figure 4. Thick turret punching tool assembly (Sundberg 2019, 15).

Tools are located in the turret. Customers can define the number of the stations for the tools in the turret when they are ordering the turret punch press from Prima Power. To make complex products the sheet metal manufacturer needs a variety of tools. If the manufacturer has only a small number of simple thick turret tools he can only make simple parts for products with them.

### 3.2 Punching

Punch assembly is pressed down with a ram; the punch impales the sheet creating a hole and goes through the die dropping a slug. (Mate Precision Tooling 2001, 5). Punching process is displayed in figure 5. The most common shapes created with punching are squares, rectangles, and circles. (Custompartnet [Ref. 12.11.2018]).

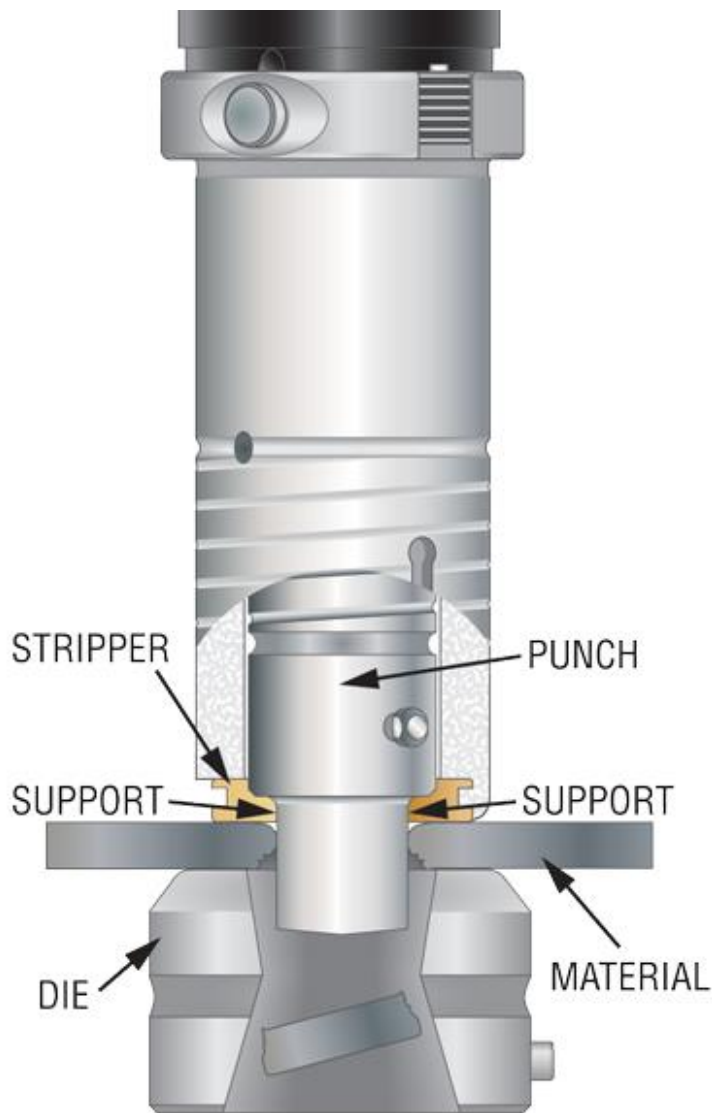


Figure 5. Operation of a punching tool (The Fabricator 2014).

For punching tools, a clearance is needed between the upper tool and lower tool because of the material reacts by expanding towards sides when it's pressed downwards with force. In punching the die, which is the lower tool, needs to have a bigger hole than the punch. If the clearances are not taken into consideration, the punch and the die will wear off lose and their sharpness quickly or even break. For every sheet metal material there are recommendations for the clearances that are calculated by a percentage of the sheet thickness. (Custompartnet [Ref. 12.11.2018].)

Table 1. Material clearance recommendations for punching and blanking (Finn-Power 2007).

<b>Material</b>	<b>Thickness</b>	<b>Clearance-punching</b>	<b>Clearance-blanking</b>
<b>Aluminium</b>	under 2.5mm	15%	15%
	2.5 – 5.0mm	20%	15%
	over 5.0mm	25%	20%
<b>Cold rolled steel</b>	under 3.0mm	20%	15%
	3.0 – 6.0mm	25%	20%
	over 6.0mm	30%	25%
<b>Stainless steel &amp; hot rolled steel</b>	under 1.5mm	20%	15%
	1.6 – 2.8mm	25%	20%
	2.9 – 4.0mm	30%	20%
	over 4.0mm	35%	25%
<b>Plastic</b>		7-8%	

Dies with greater clearances are used for materials with higher yield strengths. For example, stainless steel has higher clearance for punching than aluminium, see table 1. Stainless steels have yield strength of 170 - 1000 MPa and aluminium alloys have 30 - 500 MPa. (Materials Data 2003, 12).

### 3.3 Forming

Instead of making holes to the sheet, like punching tools make, forming tools bend or stretch the sheet. Creating shapes like louvers, embossing, marking and knockouts. The forming stroke is numerically controlled so the height of the form created to the sheet can be set precisely. (Prima Power 2018, 86-88.) An example of this can be seen in figure 6.

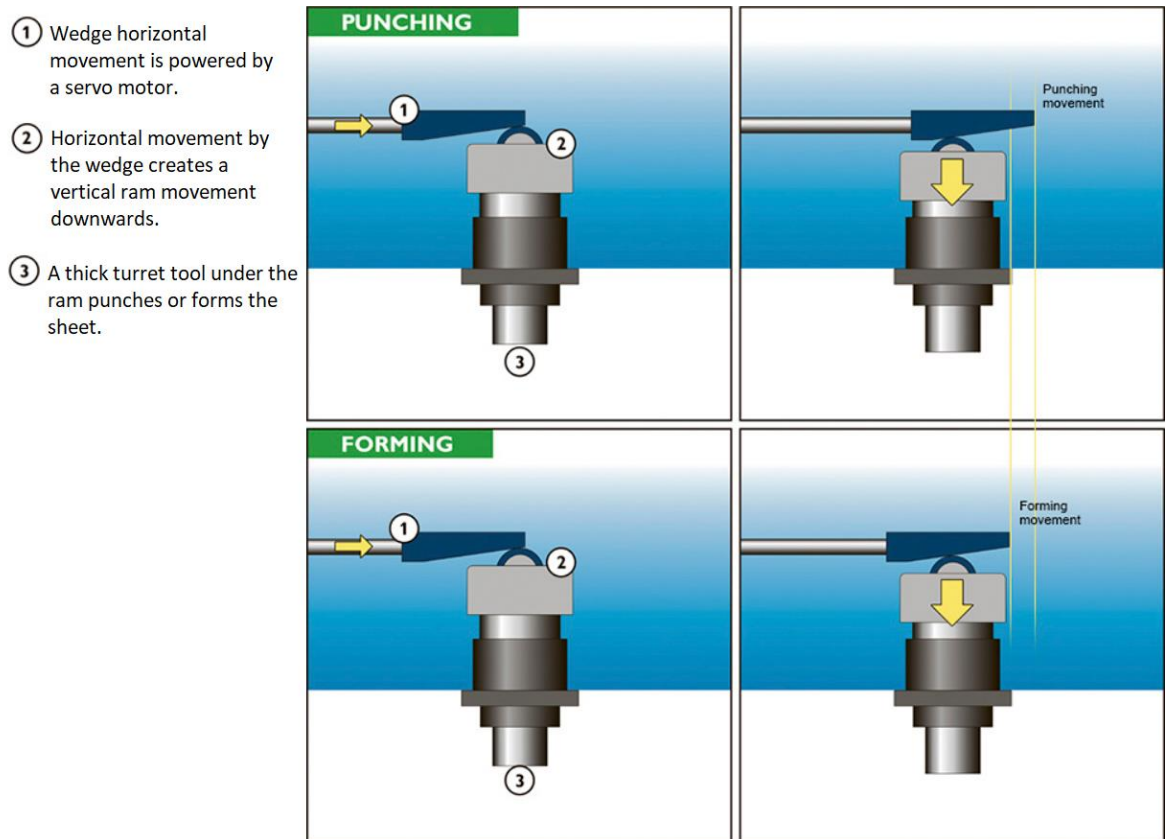


Figure 6. Difference between punching and forming ram movement (Prima Power [Ref. 13.3.2019]).

The wedge is moved a greater distance with the servo motor when punching than in forming. NC-controlled vertical forming position of the tool is higher than the punching position. This is how the forming tool is forming the sheet, not going through it.

### 3.4 Roll forming

The roll forming tool, also known as the wheel tool, is usually used to stiffen and add strength to the parts produced, see figure 7. This allows in some cases the use of slightly thinner materials and is rewarded with lower material costs. The principle for the ram movement for roll forming tools is almost the same as for the forming tools. When the ram has reached its programmed forming stroke position, it will stay in that position. Then the machine will start moving the sheet to create a form with the wheel. After the movement of the sheet the roll forming tool is lifted back up again. (Prima Power 2018, 82-83.)

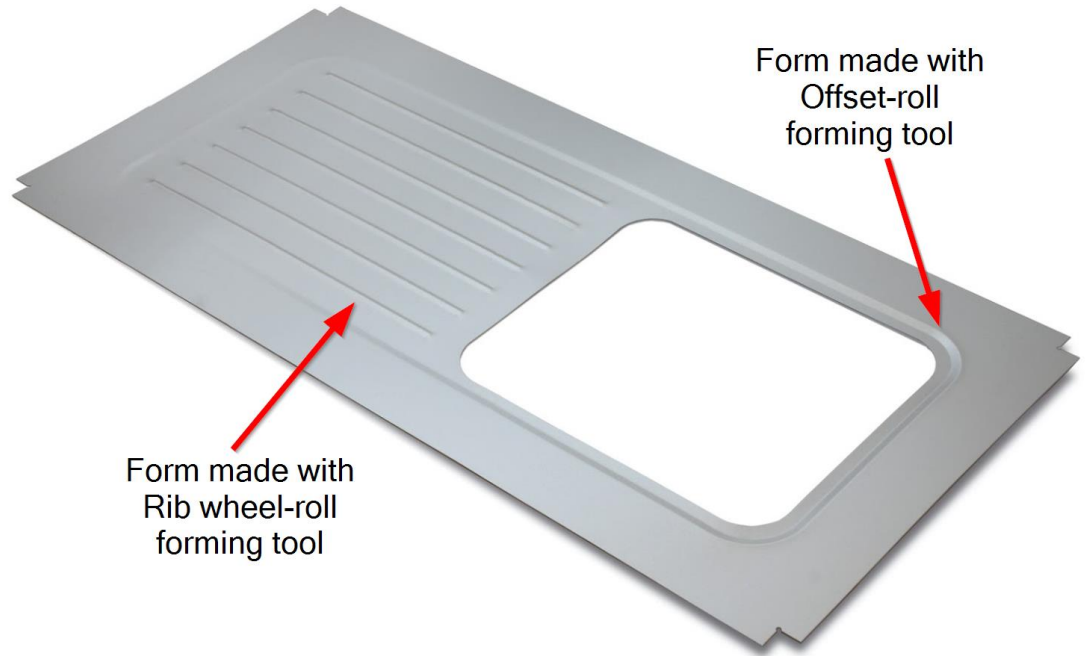


Figure 7. Roll forming tool forms on a part (Prima Power 2007).

Roll forming tools are the most complex thick turret tools to use. The arcs in the programmed roll forming shapes cannot be too sharp because the wheel of the tool can lose its grip in tight turns. Also, to avoid breaking the wheel or wheels of the tool the upper tool must be lowered to the sheet slowly while moving it.

## 4 CAM

Computer aided-manufacturing is the heart of CNC-machining. Without the programs from the CAM the CNC-machines do not operate. Poor programming with CAM can break the machine and brilliant programming can give a manufacturer advantages in many aspects.

### 4.1 What is CAM?

Using computer systems to manage, plan and control the operations of a manufacturing plant can be defined as computer-aided manufacturing. CAM is used via a direct or indirect interface of a computer with the production resources of the plant. Simply put, CAM means using a computer system only for manufacturing processes and not for designing purposes. (Elanchezhian 2005, 2.)

In-depth computer-aided manufacturing means, for example, creating G-code with numerical control software to drive CNC machines' tooling for the production of parts. Production of high-quality parts relies on the performance of CAM. (Siemens [Ref 23.11.2018].) The utilisation of high speed, 5-axis, multi-function and turning machines can be maximised with CAM (Siemens [Ref 23.11.2018]).

CAM can include a wide range of usage of computer applications:

- Model preparations with CAD,
- NC programming,
- Coordinate measuring machine inspection programming,
- Machine tool simulation,
- Post-processing. (Siemens [Ref 23.11.2018].)

### 4.2 NC Express e<sup>3</sup>

NC Express e<sup>3</sup> is an easy-to-use CAD/CAM software used by Prima Power to process a single part or a completely automatic batch of them. It can be used to

program any Prima Power laser or turret punch press. NC Express e<sup>3</sup> is able to control ERP data, import 3D models and unfold them for 2D CAM programming. NC Express e<sup>3</sup> shares the synchronized tooling and laser data via ERP with Tulus® Cell user interface at the machine PC. NC-programs made in NC Express e<sup>3</sup> can be run with two different simulations to see and verify the sequences of punching and cutting so that they are optimal. (Prima Power 2017a.)

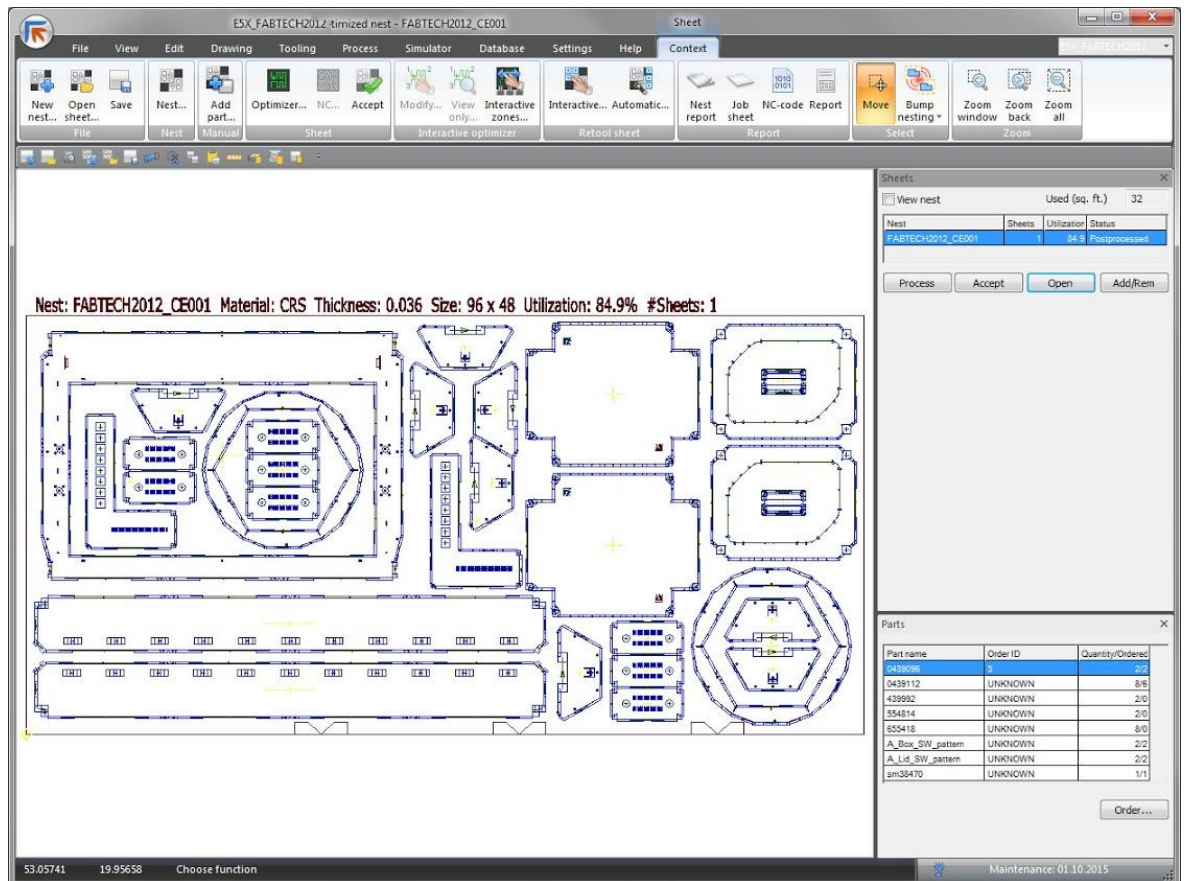


Figure 8. NC Express e<sup>3</sup> (Prima Power 2016d).

NC Express e<sup>3</sup> uses the area the metal sheets as efficiently as possible, see figure 8. Experienced user of NC Express e<sup>3</sup> is able to program swiftly several productions orders in a day and use them afterwards if necessary.

## **5 GUIDES AND TRAINING MATERIAL**

Information is needed to learn something about a subject. The material that includes that information is critical to be displayed correctly. When talking about a training situation, the training material eases the workload of the trainer. Trainees can re-examine the material, and trainers do not have to repeat explanations.

### **5.1 User guides**

User guides are quintessentially book-length instruction documents for the instalment, usage or troubleshooting of the hardware or software of a product. The page count of a user guide gets higher the more complex the product is. If the product is very complex, some of the elements in the guide get divided into separate volumes. Particularly this would be the case with the commands, installation-, and troubleshooting procedures. (McMurrey [Ref 21.9.2018].)

### **5.2 Advantages of guides**

A good user manual is a way to lower the RMA expenses of a product during its life cycle. Products will not be sent back to the manufacturer and replacements, or refunds will not be carried out for the user so often because of the correct use of the product. There are more advantages than just the financial side that are provided by a proper user manual. (Technical Writing [Ref 30.10.2018].)

It is essential to limit the legal liability if a product can be misused. Some products are extremely hazardous when misused. The items categorised to be this dangerous are, for example, devices used with high voltage, sources emitting intense light or laser beam, high temperature generating devices, and many mechanical systems. (Technical Writing [Ref 30.10.2018].)

An engineer or a sales man can save time when it does not need to be wasted on consulting the user. The more explicitly the manual is written the less a salesman or an engineer needs to spend time on advising the customer to use different functions



of the device. To produce a manual a very highly skilled technical writer is required. Sometimes to get the right perspective a writer from outside of the company is needed. (Technical Writing [Ref 30.10.2018].)

The user manual can be also used as a sales instrument. The engineer who is going to use the product can learn the positive aspects and more specific information on the product from the manual. The user manual is usually asked to be delivered before the customer will ask for a quotation. (Technical Writing [Ref 30.10.2018].)

Manuals are in a big role in giving a positive image of a company. It is very unbeneficial to have the customer having to figure out the products while reading the manual. The manual can be as simple as some technical papers that will raise the customer's interest and result in a positive state of regarding the business in question in a short period of time. This will be a good start for a cooperation between a company and the customer. (Technical Writing [Ref 30.10.2018].)

### **5.3 Training material**

Preparing the material for training is usually the most work requiring and time-consuming part of the training. It is invisible work that is never realised to be a part of the trainers' work contribution. In most cases, the trainers have to do this during their spare time while doing other work during the working hours. The primary objective of the training material is to support learning. The functionality of the material can be estimated by questions like:

- Is the material clear enough when observing its content and layout?
- Can the participants understand the material on the basis of their knowledge or does it need to be simplified or diversified?
- How is the material supposed to be gone through: alone or together, and before, during or after the training?
- Is the material versatile enough: have different kind of forms of presenting the material been used (i.e. slide-, mimeograph-, flip chart) side by side?
- When is the material given? All at once or in sections? (Koski & Kupias 2012, 74-75.)

## **6 GUIDE PROJECT**

The guide was made during trips to many different countries around the world. Observations of how the operators learn the tool training, were taken into consideration when planning the structure of the guide. The guide has been tested in three different locations.

### **6.1 Starting situation**

Before the beginning of this project, there was no actual guide for new operators to follow through every step of using a thick turret tool. Pieces of tool information were scattered around documents, and the operators had to scavenge the data from different sources before the training. The customer trainers were the only source where the operators were able to get blanket information on this subject. Technology and Training Center personnel at Finn-Power decided that a guide has to be made for this information to be centralised in one document that will be sent to the customer before the starting point of the training.

### **6.2 Ideal situation**

From a trainers point of view the best start for the training are motivated operators that have a genuine interest in the subject. Motivated operators will not lose their focus, start doing other things, be late from training events or argue about things that are not relevant regarding the training. The operators desire for more information can be seen as group support amongst them. They will help each other to understand the current subject and pursuit the next phase of the training as fast as possible.

For Finn-Power as a company, the ideal situation is to get the customer trainer to visit the same customer as few times as possible. This means time used for the training per project and the costs for trips are minimised. When a customer is adequately trained and can operate the sheet metal machinery independently, the customer trainer is not tied to that project anymore and is a free resource for another

project. Now when a new project is started the customer can get their training in time, and Finn-Power gets a more positive impression.

### **6.3 How to achieve the goal**

Giving the operators some information to prepare themselves is an easy way to motivate. This way the operators will get interested more easily about the subject that they are going to be trained because they already know something about it. They will be eager to start teaching other operators, in example how the tool parameters are set correctly to a specific tool, if they do not understand it right away. This might form a competitive situation among the operators and have a positive effect on the outcome of the training when the operators are trying to acquire as much information as possible about the subject.

The trainer giving operators the material to prepare themselves has to make sure that the material presented is suitable for the “getting ready for training”-phase. The material has to be just scratching the surface of the subject, easy to read, tendentious and depending on the issue, highly illustrated. If it is too complicated and going in too deep to the issue, the operators might get confused from the amounts of information, and that will cause the loss of motivation to study it by themselves. They will wait for the training event to be carried out, because the trainer will teach the basics and the advantage of pre training material is lost.

The Thick Turret Tool Guidelines-document was planned to be easily understood. It includes instructions for the thick turret tooling in the CAM software and in the graphical user interface at the machine PC. Also, the instructions for physical instalment of the thick turret tools are included in the guide. This guide will be sent to the customer one week beforehand the customer trainer arrives to train the machine so they can prepare for the training.

## 6.4 Structure

The structure of the guide has to be similar to the process of taking a new thick turret tool into use, see figure 9. The order goes as follows:

- Telling about the tools what they are and how they operate,
- Creation and parameterisation of a thick turret tool in the NC Express e<sup>3</sup>-CAM,
- Installation of a tool in Tulus® Cell-software in the machine PC,
- Physical instalment of a tool at the turret punch press.



**Subject:** Tool guidelines  
**Product / Control:** Thick turret tools  
**Series / Version:** 1.0

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Figure 9. Structure of the Thick Turret Tool Guidelines.

The guide helps in making the order of creating a tool clear for the operator. The knowledge of tool creation process will help the operator, who is going to be operating the machine in the future, to troubleshoot problems easier when he/she knows where the problem might have its roots.

## **6.5 Gathering information**

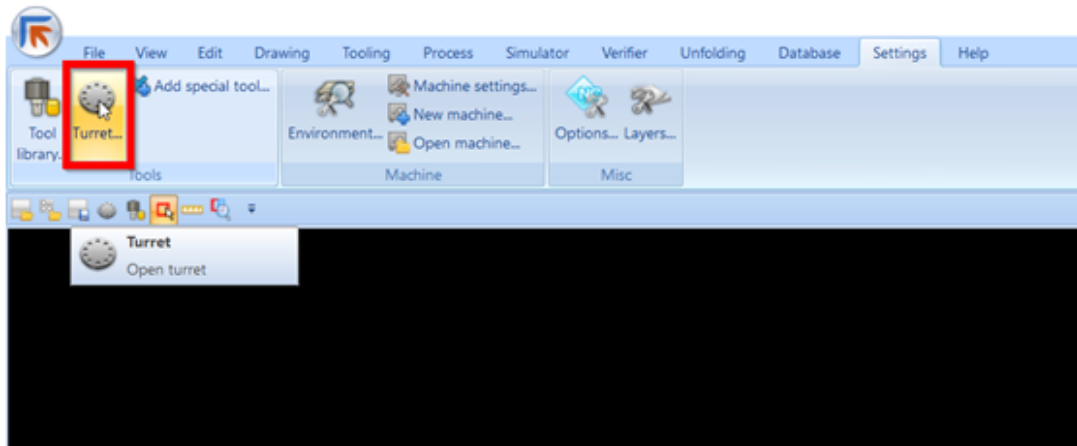
The information regarding the thick turret tools can be found from several sources. The information has been gathered from Finn-Power- and Prima-Power training documentaries, the manuals made the by tool manufacturer, and the customer trainers.

The operation principles of tools rarely change, but some of the ways tools are handled may differ when newer models are brought into the market. For example, the die clearances for punching tools are always the same because of the materials they are used to have specific yield strengths that don't change. But then again a new multi-tool can differ from an older version on how it has to be assembled or maintained. Some of the information used in this guide is from quite old sources, and some are from brand new.

## **6.6 Appearance**

The guide is mostly filled with pictures. The operator will be guided step by step in every phase of creating a tool. What buttons to press are highlighted in the guide clearly, and the order is always numbered if there is more than one button to press. Pictures from the software (NC Express e<sup>3</sup> and Tulus® Cell) are raw screenshots and have been edited with Greenshot. Pictures from tools and physical installation of them to the turret are taken with a camera. The text is kept to the minimum, so the operator does not have to read a lot.

First you need to open turret by clicking Turret-button.



Then click view on the Turret-dialog.

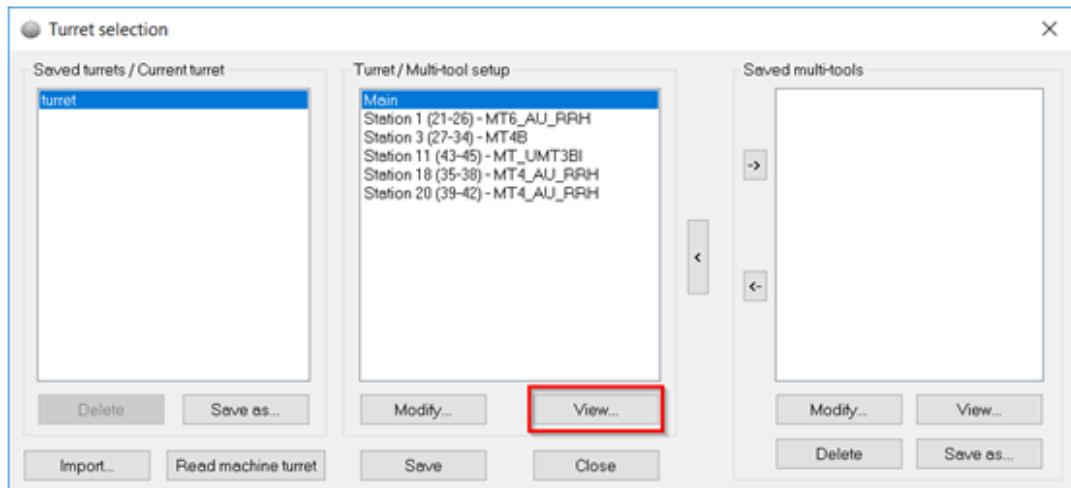


Figure 10. Example of guidance: Opening the turret in NC Express e<sup>3</sup>.

Buttons are highlighted with red rectangles. There is an explanation of what action to take on top of pictures of the dialogs that pop up when creating the tool, see figure 10. If the operator does forget to define a parameter while creating the tool it is easy to look from the Thick Turret Tool Guidelines where the problem might be.

## 6.7 Extent of information

The guide will be a part of an introduction course so the amount of information cannot be overwhelming. It was decided that only one thick turret tool type has to be taken into more deep contemplation and that one was the punching tool. It is the

most simple of the three (Punching-, forming- and roll forming tools) and has the least parameters to set in NC Express e<sup>3</sup>. As it can be seen in figure 9, all of the three were introduced, but the punching tool was the only to be set in NC Express e<sup>3</sup>. In Tulus® Cell the creation process of a tool is more straightforward, and that is why more tools were created in that section. Although, when using the NC Express e<sup>3</sup> as the CAM to make programs for Prima Power turret punch presses, the tools are created automatically in Tulus® Cell after importing the program. The Tulus® Cell tool creation is critical only when the operator will be using a third party CAM.

## 6.8 Feedback

Feedback from the guide was gathered by giving an answer form after the training regarding the Thick Turret Tool Guidelines-document to the operator. Answers were gathered from Finnish and foreign sources to get more depth into the query. The document was reviewed by Ukrainian distributor of Prima Power machinery, Kuwaiti customer of Prima Power and one of the Prima Power customer trainers. There were seven questions, one for each section of the guide, with four different answer options “Very useful”, “Useful”, “Little useful” and “Not useful at all”. Also, the eighth and last question was “Other feedback” for more deep analysis.

Questions asked in the form:

1. Introduction of the guide,
2. Presentation of tools,
3. Punching tool information,
4. CAM-section,
5. Tulus® Cell-section,
6. Tool installation,
7. Structure and the guide as a whole.

Table 2. Answers.

<b>Answers to:</b>	<b>Ukrainian distributor</b>	<b>Kuwaiti customer</b>	<b>Prima Power customer trainer</b>
<b>Question 1</b>	Useful	Useful	Useful
<b>Question 2</b>	Very useful	Useful	Very useful
<b>Question 3</b>	Very useful	Useful	Very useful
<b>Question 4</b>	Very useful	Useful	Very useful
<b>Question 5</b>	Very useful	Useful	Useful
<b>Question 6</b>	Useful	Little Useful	Very useful
<b>Question 7</b>	Useful	Useful	Very useful

Unfortunately the haste in Ukraine and Kuwait left other feedback-question unanswered. Question 8 was answered only by the customer trainer of Prima Power:

“The guide is very useful as a whole. I wish I would have had this kind of instruction about tools, when I started working for the company. It would have helped me a lot to get started with my work, because many things regarding to installation and CAM-parameters of tools were difficult to remember.

The guide lets you understand the basic principles about tooling and installation of tools, which is useful especially for someone who doesn't have much experience about this subject. I think this guide would be a good tool for customers also, because they usually get confused with all the new information about tooling and installation of all kinds of tools. Now they have a guide to check these settings from.”



## 6.9 Analysis

From each answer the particular section of the guide obtained a certain number of points. Figure 11 displays vertically the number of points each section got.

- Very useful = 4 points
- Useful = 3 points
- Little useful = 2 points
- Not useful at all = 1 point

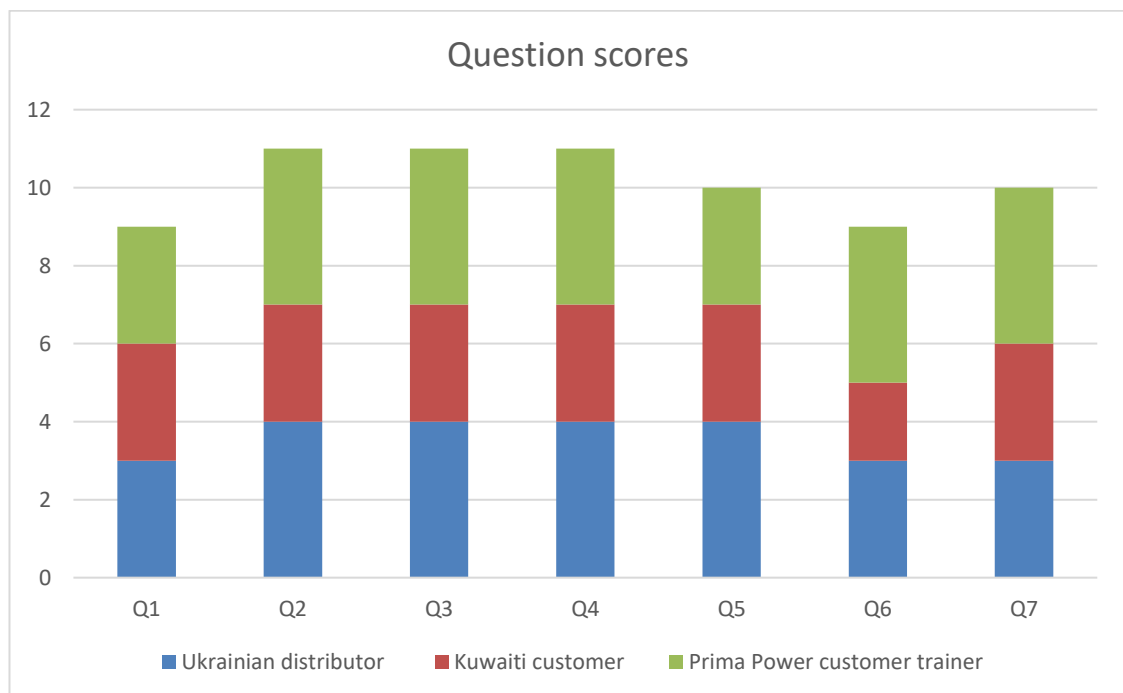


Figure 11. Summary of the scores per section.

As seen in table 2: question number 6 “Tool installation” has collected one “Little useful” answer. Tool installation is the shortest section of the guide. It could be longer, but there already is a 3D-guide being developed for tool installation, and that will be replacing this part of the guide in the Moodle environment.

The answer form was given after the training itself. This may have affected the score of the questions to be high because the operators already knew the thick turret tooling well. If the form had been given before the training, the score could have been lower given that the operators would not have used any of our products at that point.

The customers' flawless run of the turret punch press cannot yet be concluded as the result of the Thick Turret Tool Guidelines-document when taking the magnitude and time frame of the query into consideration. However, Prima Power customer trainers figured that the guide makes some parameters in the software clear in what they mean. This indicates that the guide reached the goals it had been planned to.

## **7 CONCLUSIONS**

The guide was made in two months and the testing period of the guide lasted three months. Challenging was to find the right customer to test the guide on. The operators of the customer had to be able to give comprehensive feedback.

### **7.1 Benefits**

During the training of the new users of a turret punch press, it was easy to notice from a trainer point of view, that it was more comfortable to go through the thick turret tool-section of the training when the operators had studied the Thick Turret Tool Guidelines beforehand. Because the amount of time spent on the training of tools was less than before the time to run the machine with the operators was greater. Running the machine is the best way to train because then problematic situations where alarms stop the machine are likely to occur and the operator operating the machine has to start troubleshooting to find a way to continue the production.

### **7.2 Future applications**

Every feature of Prima Power product family is continuously changing and developing because of the increasing competition in the global markets of sheet metal fabrication machinery and systems. User interfaces change, machine automation levels get higher, process speeds become faster, and customers are more demanding concerning the reliable delivery of the machines. This means the features of the products will change and that leads to the changing of the user guides of these products also.

This user guide has to be kept up to date. New thick turret tools, CAM- and machine user interface updates might change the way a tool is used. At the moment interactive 3D-guides are being developed by Prima Power. They will be used for training of the customer before and after the purchase of the machine. After getting enough feedback on this guide, it is possible to start improving the 3D-guide for thick

turret tooling. The guide will be highly interactive and more comprehensive than ever before.

### **7.3 Summary**

The guide provided some proper preparing for the operators that were trained. The training was a bit narrower on the tools because the operators did some studying beforehand and time was saved on the training. Some improvements are to be made for the guide to make it easier to read for a first-timer. Although, when one is new in the sheet metal fabrication industry and starts reading guides regarding it, the contents are never going to be easy to comprehend.

Clear guides are an excellent way to improve the efficiency of training sessions. They are very time consuming to make because the trainers have to set themselves in the position of the operator and try to understand what are the eureka moments they feel when reading the guide. The time spent on making it will be worth it because the time saved in several upcoming training sessions will be exponentially more.

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