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SINUMERIK – step ahead with coreboot

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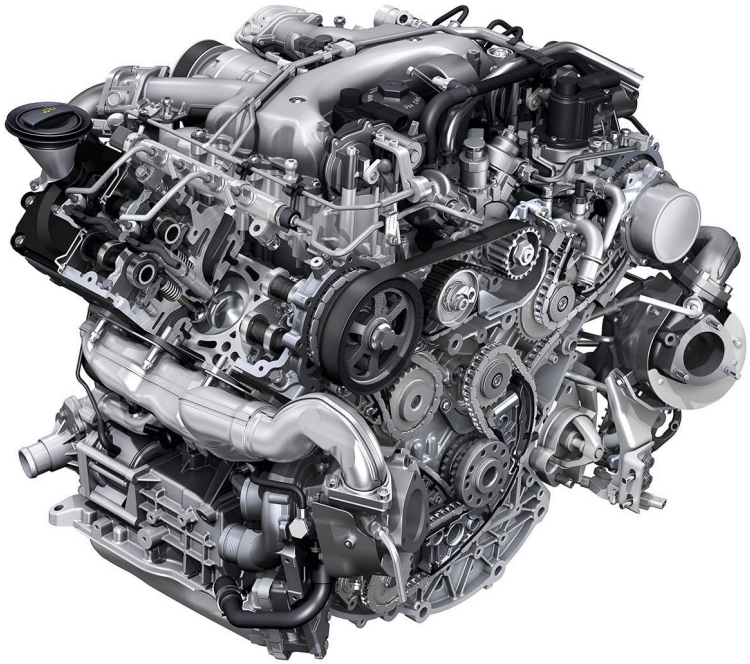
Who am I

- Werner Zeh (aka norwich on IRC)
- Work for ~10 years for Siemens
- Did hardware designs in the first 4 years
- Now dealing with x86 firmware for over 6 years

What is a CNC exactly?

- Everybody knows a car and the complexity of it’s modern engine



- Every single part has to be manufactured in high quality and quantity with as little time effort as possible

https://images.cdn.autocar.co.uk/sites/autocar.co.uk/files/images/car-reviews/first-drives/legacy/diesel0ac-033.jpg

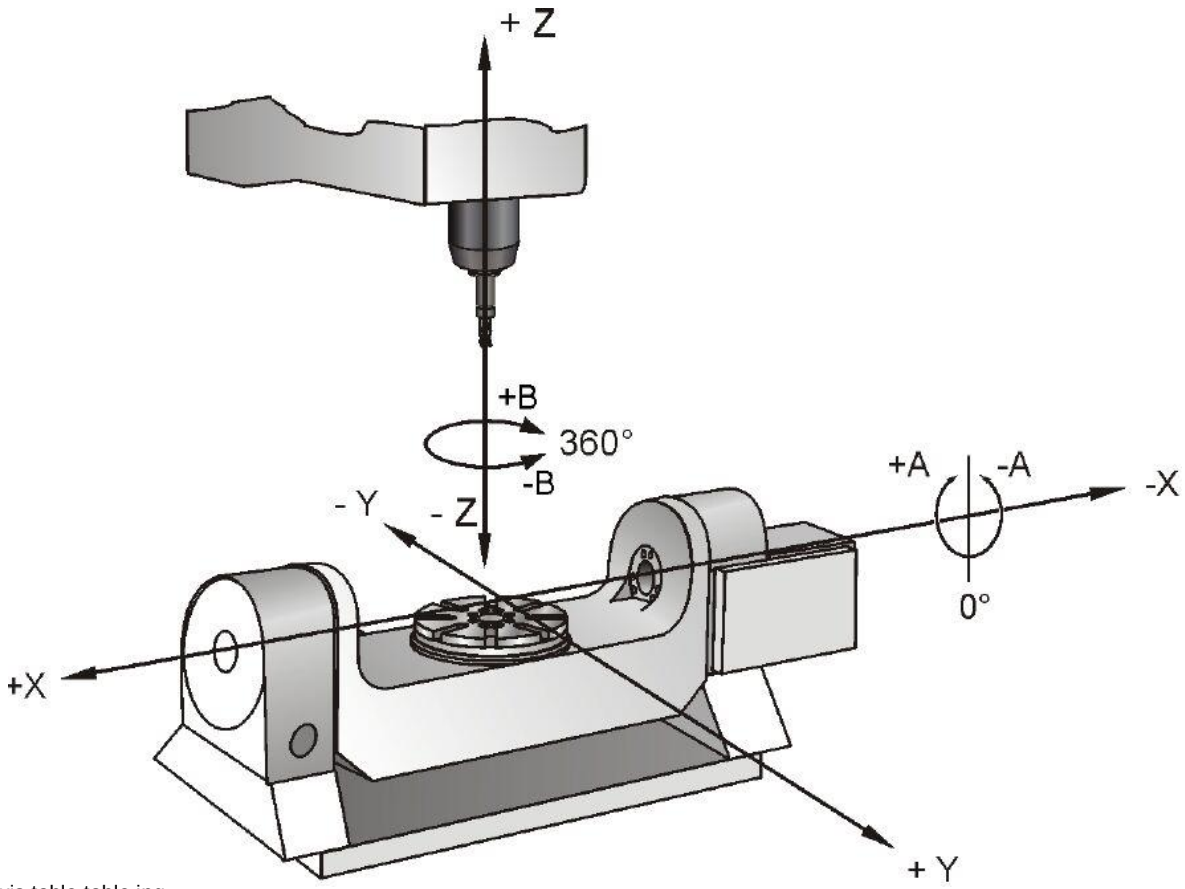
What is a CNC exactly?

- The manufacturing of such complex metal parts is done in high-end CNC-machines, which can look like this.
- They can have multiple axes for both, the tool and workpiece.

http://www.machiningnews.com/wp-content/uploads/2015/09/DMG-MORI_ecoMill-800-V_cikk.jpg

What is a CNC exactly?

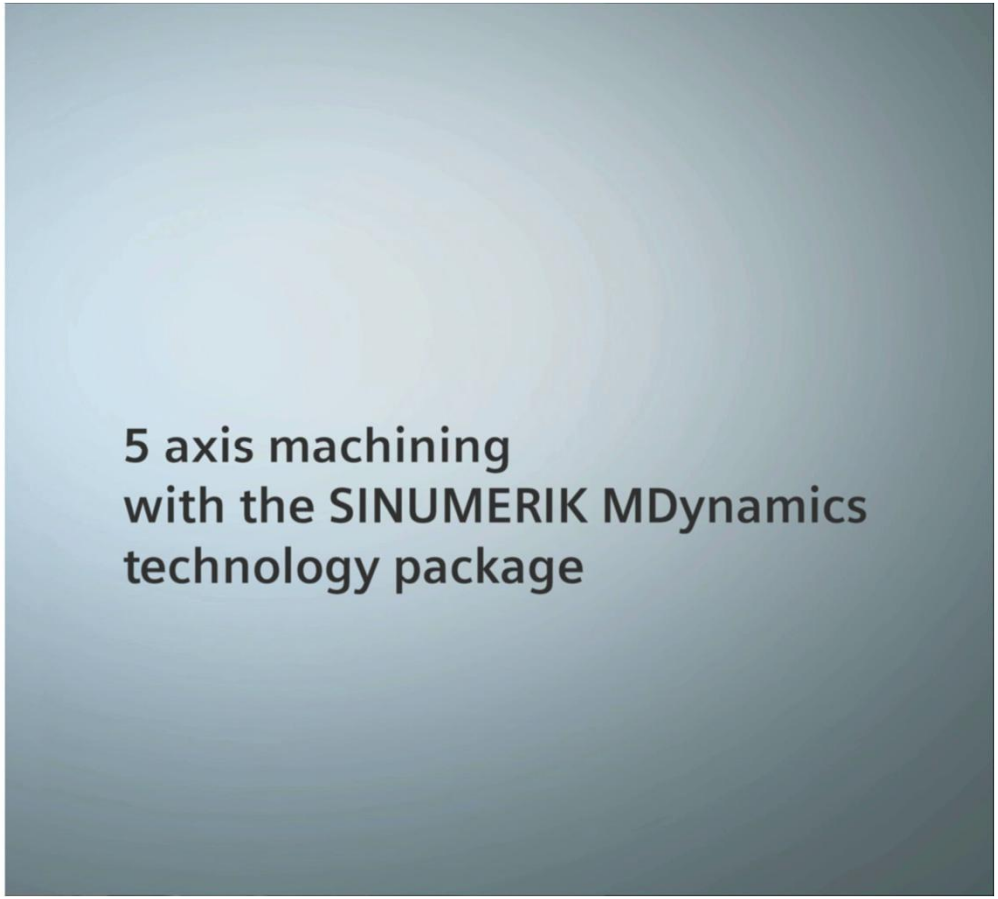
The term “axis” defines a independent possible motion direction of either the tool or the workpiece inside the CNC machine. Here a 5 axes table example.



http://www.mfgaa.com/5axis.table.table.jpg

What is a CNC exactly?

Engine crankcase finishing in a milling CNC-machine



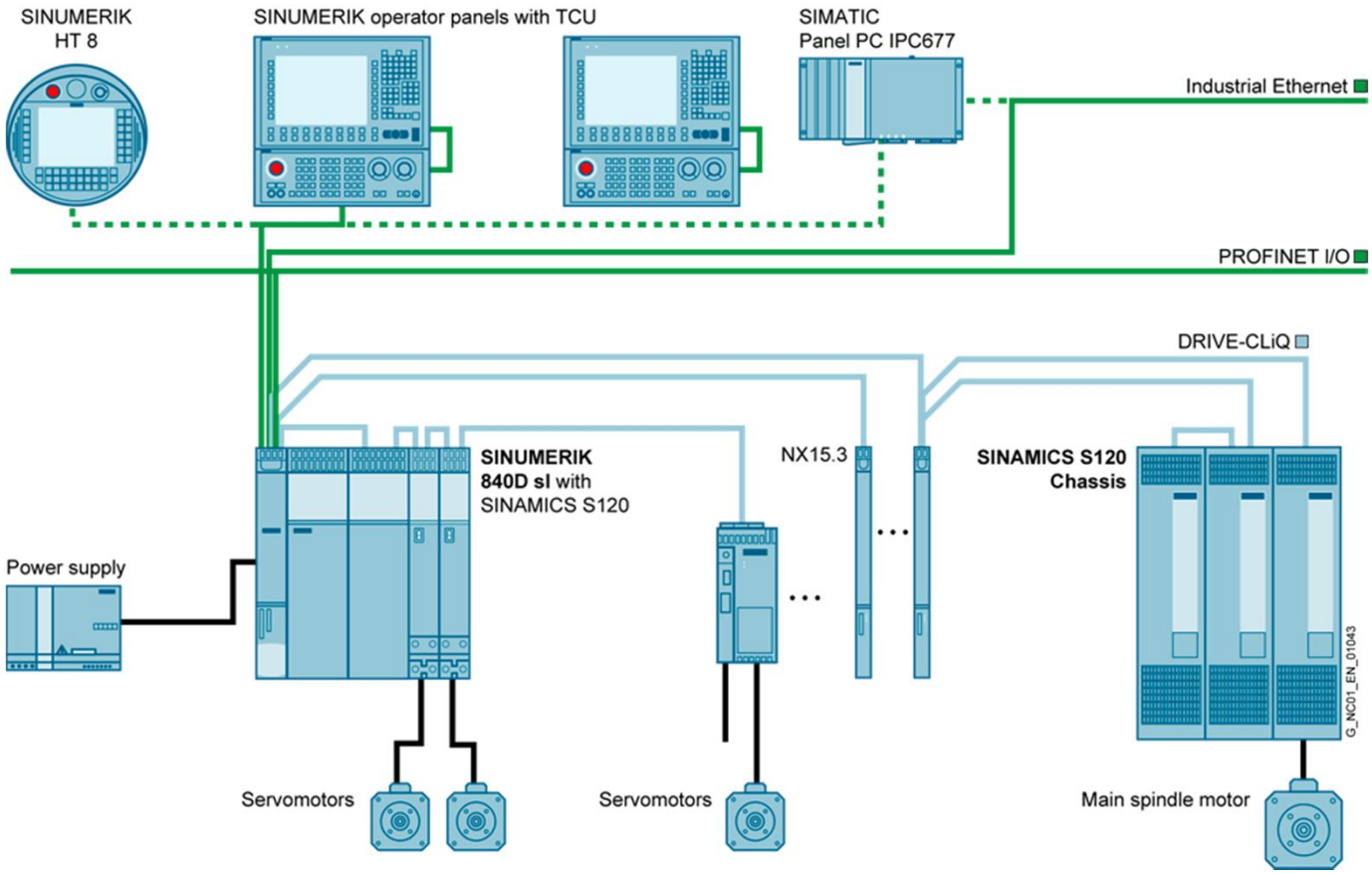
What is a CNC exactly?

- Obviously a set of smart devices to coordinate all the needed motions for all axes to achieve this result are vital for the machine:
  - Ø at least one motor with an encoder per axis to move it as needed
  - Ø a power inverter to control the torque and speed for every single motor
  - Ø a control unit that coordinates every motion of the axis and other tasks inside and outside of the machine
  - Ø a user interface where the operator is able to control the machine

- The SINUMERIK Numerical Control Unit (NCU) takes the part of coordinating all the task inside and outside of a CNC machine.
- The SINUMERIK Operator Panel (OP) among with the Machine Control Panel (MCP) provide the user interface and communicate with the NCU

What is a CNC exactly?

- A typical topology of the electrical equipment of a CNC machine can look like this
- Range scalable according to the functionality of the machine tool



http://www.automation.siemens.com/bilddb/search.aspx?lang=en

SINUMERIK – Scalable solution for CNC machines

- SINUMERIK is an embedded system
- It deals with everything that is needed to control motors in a complex CNC machine and provide different interfaces for the production process
- SINUMERIK is well scalable to match the customer demands and provide solutions for different applications
  - Number of supported axes, performance, machine setup, …
- Has hard real-time requirements as we are dealing with moving masses and the workpiece quality needs to be high
- The hardware of the NCU is mostly fixed with limited options for extension
- Uses self-tailored Linux as OS
- Main computing power is taken from x86-CPUs

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Booting a SINUMERIK before coreboot

- Buy reference implementation of a BIOS/UEFI from a vendor
  - Legacy x86-BIOS fully written in assembler
  - Switched to UEFI once it was available
- Modify the reference BIOS/UEFI to add our special needs
  - support for onboard ASICs and FPGA
  - treat cold boot vs. warm boot correctly
  - adjust interrupts and DRAM configuration
  - tune BIOS execution time to be as little as possible
  - turn off setup utility
  - … and many other things
- Do all this again and again with every new platform!

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How coreboot helps us

- Open source and therefore better in security
- Higher code quality due to the very high quality standards in coreboot
- No license fees
- The amount of source code is much smaller than other firmware solutions and therefore easier to handle
- Execution speed is amazing (~300 ms to payload on Baytrail CPU)
- Once a feature is implemented it can be used by different platforms
- No setup utility available and therefore no need to disable it
- As coreboot is used for multiple platforms there is a good chance to know it much better
- Can boot into Linux as payload directly which saves additional time

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The process of coreboot being accepted at Siemens MC

- First contact with coreboot in 2011 as legacy BIOS really drove me crazy
  - Ø Just driven by myself
- First proof of concept with coreboot in 2012 on our low-end and outdated numerical control unit based on AMD's LX800
- Most of the work was done in parallel to my "real" work out of my own interest
  - Ø That time nobody in project management and architecture took me seriously
- First attention from management after porting coreboot to our latest NCU (Core i "Ivy-Bridge") in 12/2013
- Decision for switching from UEFI to coreboot for SINUMERIK products in 2014
  - Ø An important factor for the decision was the support for latest Intel platforms in coreboot (where FSP still matters)

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The process of coreboot being accepted at Siemens MC

- The claim was not just to take but contribute as Siemens to the community
  - Ø This was a no-go at that time…fear of giving something away which might become a benefit to a competitor
- Beside the pure source clearing process and the technical aspects a change in the mindset was needed deep within the division
- The whole process to change the mindset and establish a process for community interaction took nearly 1 year of work
- Finally the first official commit from me as a Siemens employee was on 2015/02/10
  - Ø *b474abe - Baytrail_fsp: Make ME path configurable in menuconfig*

The future of coreboot at Siemens

- MC segment will continue to use coreboot as the x86 firmware on the SINUMERIK platform
- Other divisions have shown interest in evaluating coreboot for their x86 based platforms
- At least one additional division is willing to switch from UEFI to coreboot for their products
- A small community is now available within Siemens which deals with coreboot

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Siemens [DF MC] relies on coreboot

- As shown coreboot is an important factor for SINUMERIK devices
- We will do our best to support coreboot and take our responsibilities seriously
- FSP needs to keep its place in coreboot
  - Ø Though FSP is a blob it enables coreboot support for latest Intel platforms. That helps users of coreboot with limited firmware development power.
- As we use Intel's latest IOTG-platforms we will need strong support by the FSP-teams at Intel
  - Ø The back and forth on Apollo Lake between different Intel working groups and the community will hopefully stay a single case!
- The openness of the project itself and the community helped us a lot to step in and finally switch over completely – Thank you, community!

Questions

Thank you for your attention!

Siemens AG

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siemens.com/answers