Product development in mechanical engineering with open-source software

A guide for small machine manufacturers in the European Union

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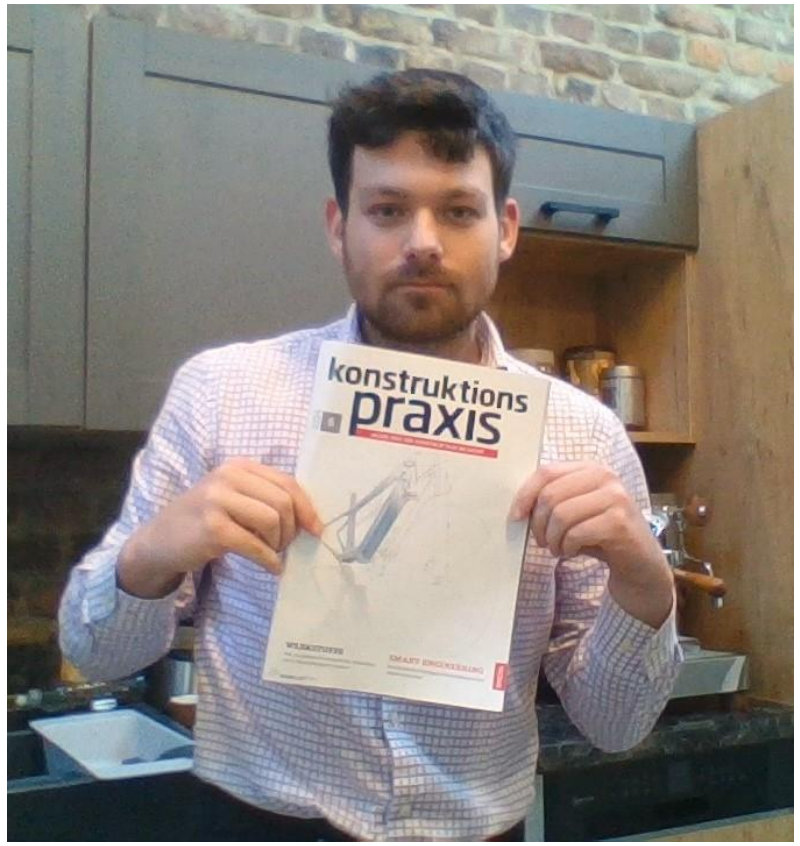
My personal story – How this talk came to be

- Passionate about becoming a machine manufacturer in Germany, mechanical engineering student
- Learned about FreeCAD, because I couldn‘t open my own project of a 3D printer with a heated build chamber, after my Catia V5 student license expired
- Stopping sales of my workholding fixtures, designed in FreeCAD because I leanred about patents and product safety
- Learning how to work with patents and how to ensure product safety at German machine manufacturer GROB
- Helping others become machine manufacturers in the European Union

=> Providing a guide for product development in mechanical engineering with open-source software



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Understanding who this guide is for

Manufacturing start-ups

Help makers become manufacturers by demystifying patents and product certification, lowering fear and perceived risk, which in total aids in creating innovations. Provide a free and open-source workflow blueprint for product development and bringing new products to market.

Established machine manufacturers

Provide options on how to implement the steps of the product development process using open-source software.

FreeCAD community

Showcase FreeCAD into context with other software and spread the word about it so that we can make it the default CAD software in the industry.

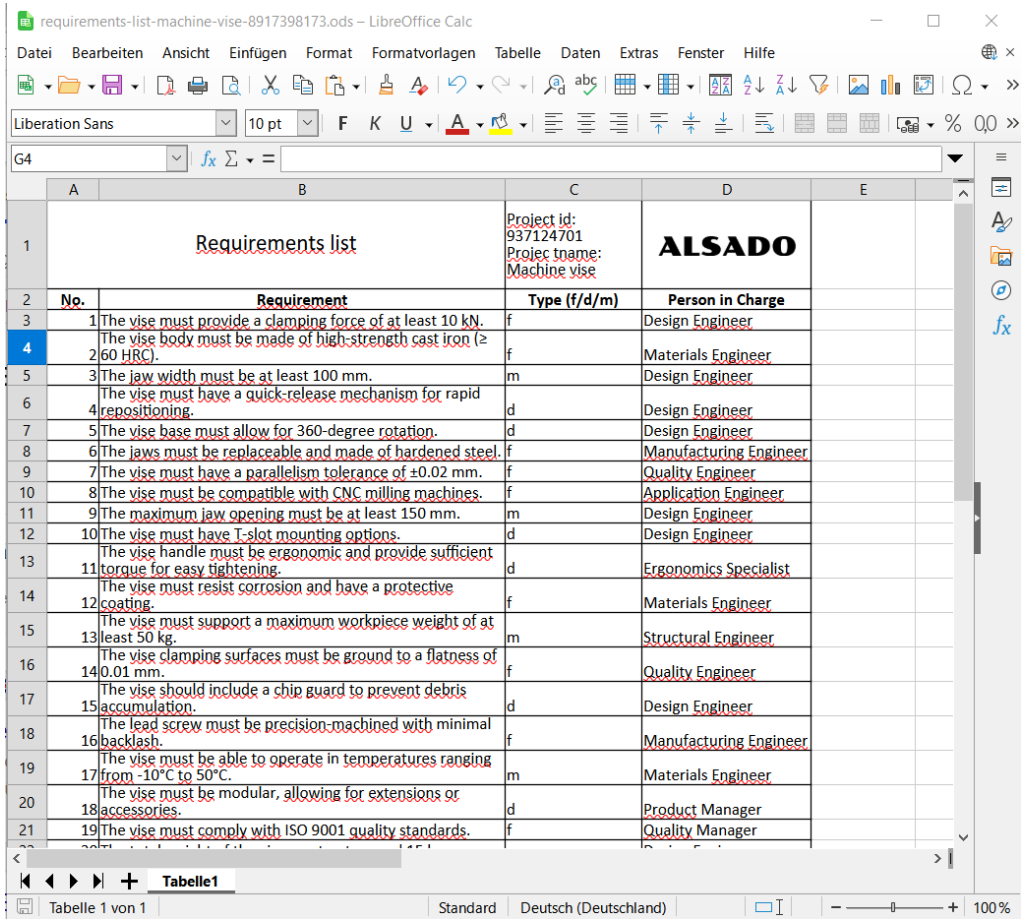
Getting an overview of the product development process

1. Defining requirements in LibreOffice Calc
2. Finding inventions in public domain on espacenet.com
3. Keeping track of inventions with LibreOffice Calc
4. Creating product concept variations using LibreOffice Calc
5. Picking a product concept using LibreOffice Calc
6. Product safety (CE), including risk assessment using LibreOffice
7. Preliminary design using LibreOffice Calc
8. Detailed design in FreeCAD
9. FEM Simulation in PrePoMax
10. On-premise product lifecycle management using Subversion
11. Alternative: Google Drive
12. Benefits of a PLM solution

Defining requirements in LibreOffice Calc

- Requirements list keeps all project members on track with the project goal
- Is based on the research performed for the target market of the new product
- Requirements list consists of columns:
  - „No.“
  - „Requirement“
  - „Type (f/d/m)“
  - „Person in charge“

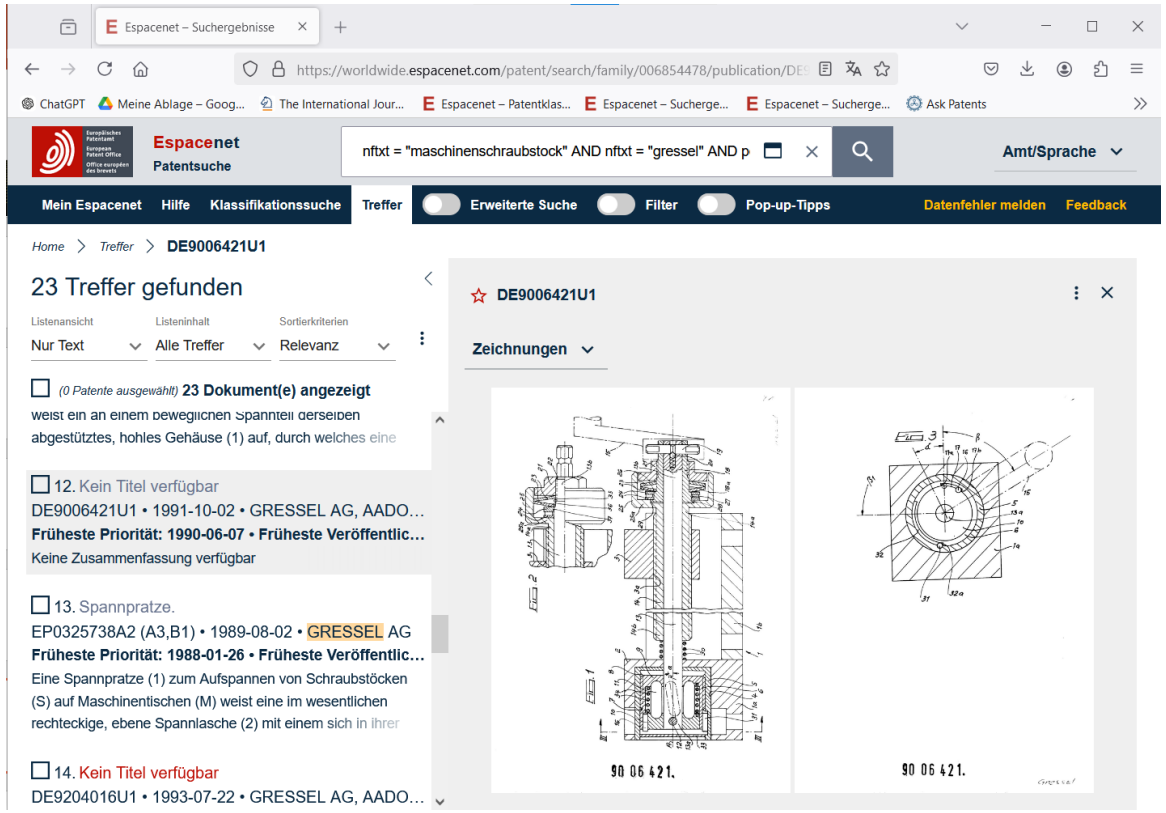
Software used: LibreOffice Calc



Finding inventions in public domain on espacenet.com

- Form a search query that limits the 150M available patent documents to 200 results by using filters:
  - IPC/ CPC class from initial search
  - Use Keywords from requirements
  - issue date more then 20 years back
- Find infringement-safe inventions from public domain (>20 years)
- Add suitable to „My Patents“ on espacenet.com and narrow down the results from 200 to 20.

Software used: www.espacenet.com



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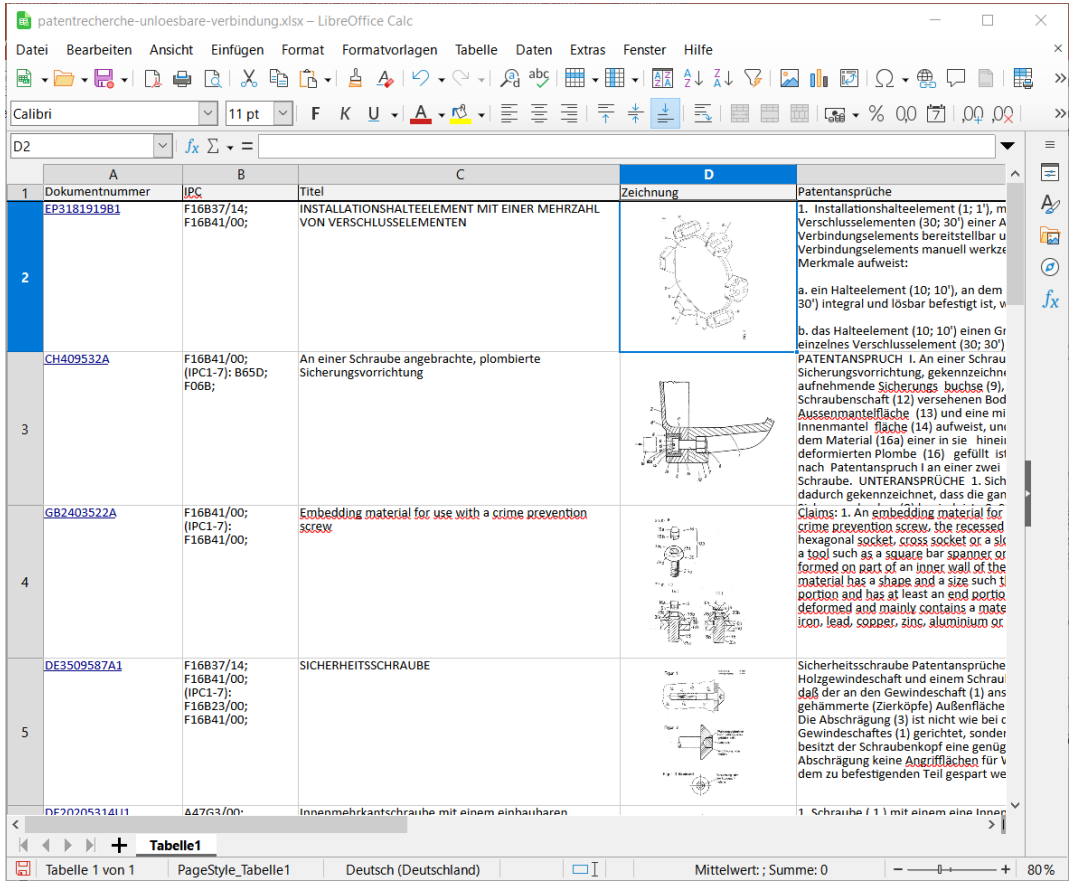
Keeping track of inventions with LibreOffice Calc

- Patent document list lets you keep an overview of all suitable inventions for your product
- List 20 most suitable documents from patent search on espacenet.com with:
  - Document number as link to espacenet.com
  - Title
  - IPC/ CPC
  - Representative drawing
  - First claim or all independent claims



Software used: LibreOffice Calc

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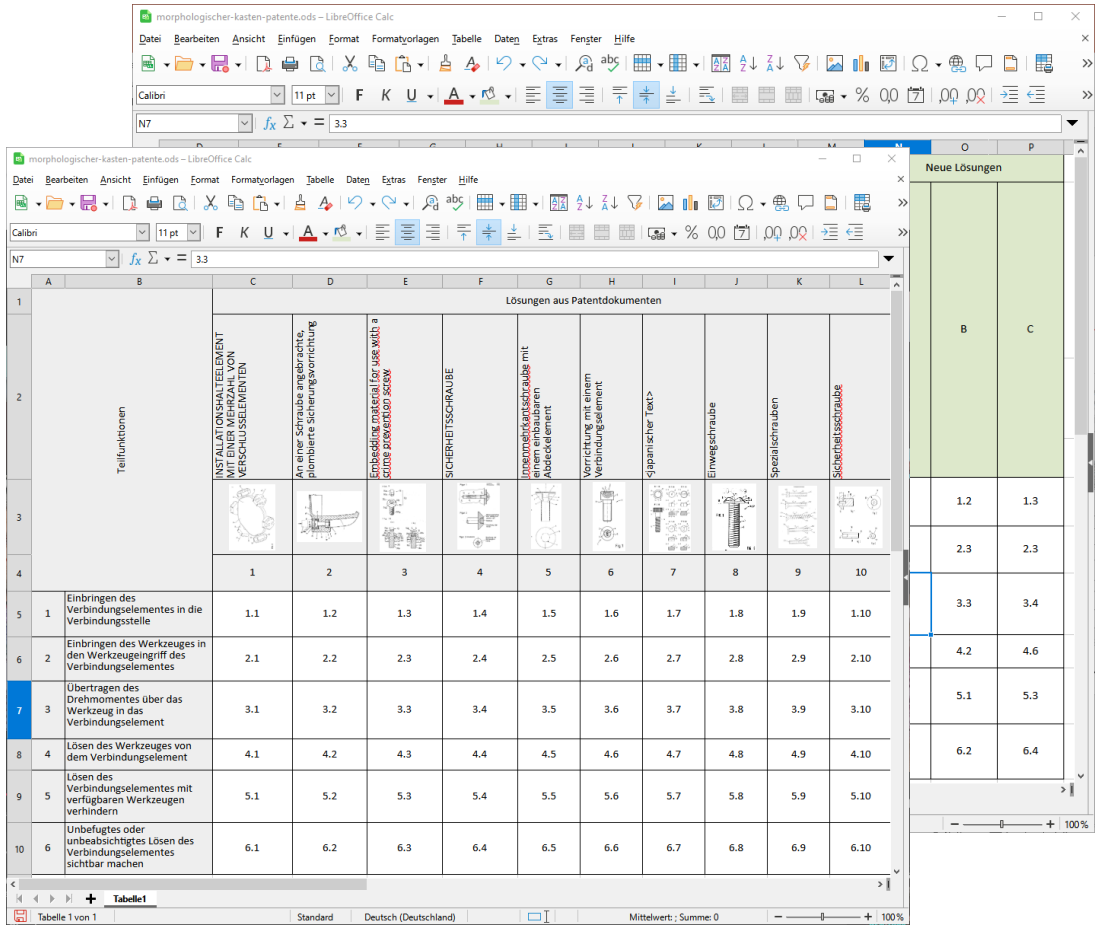
Creating product concept variations using LibreOffice Calc

- Divide up the overall function of a product into sub-functions in the sense of a functional structure
- List all sub-functions of a product and create columns with all 20 found patents as possible solutions to each sub-function
- Name each solution-sub-function pair with 1.1, 1.2, …
- Create product concept variations by combining different solutions as columns named „A“, „B“, „C“, … from patent documents, one solution for each sub-function.

Software used: LibreOffice Calc



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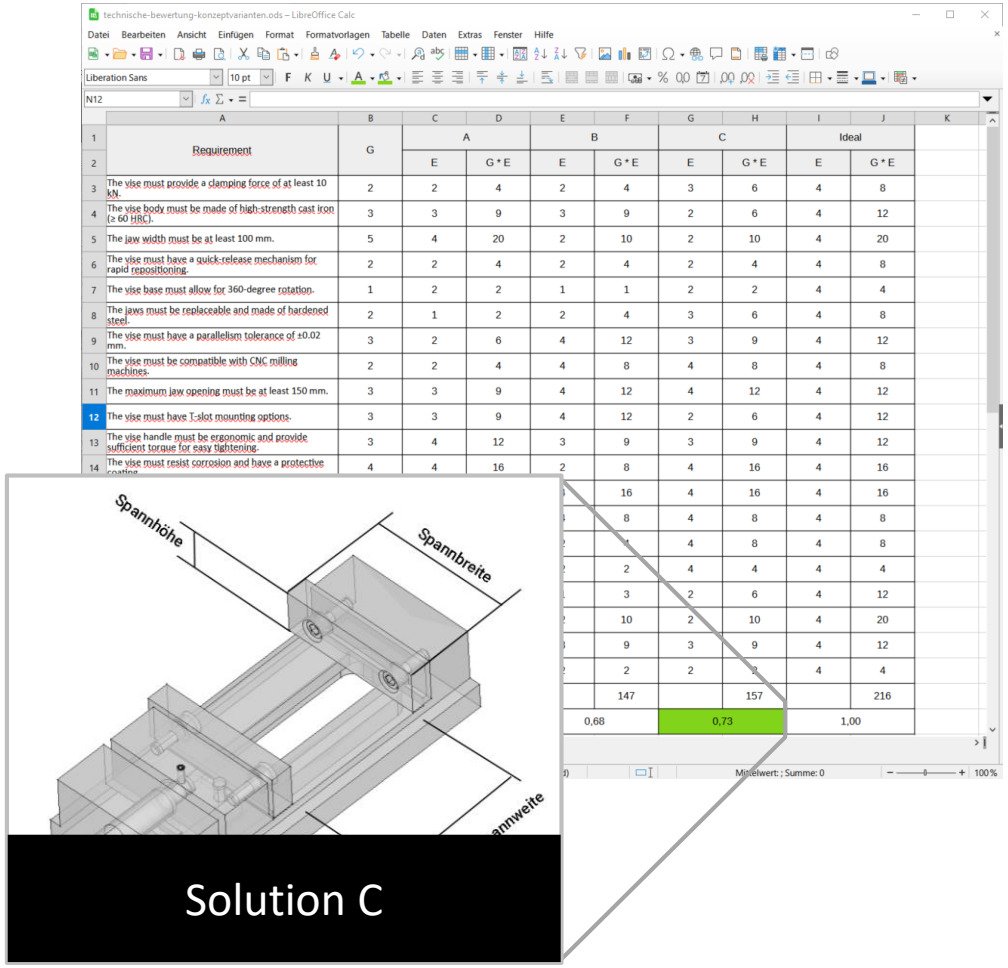
Picking a product concept using LibreOffice Calc

- Evaluate each of the product concept variations based on their suitability for the requirements
- Create a sketch of the most suitable product concept on paper or as a digital mockup

Software used: LibreOffice Calc and LibreOffice Impress



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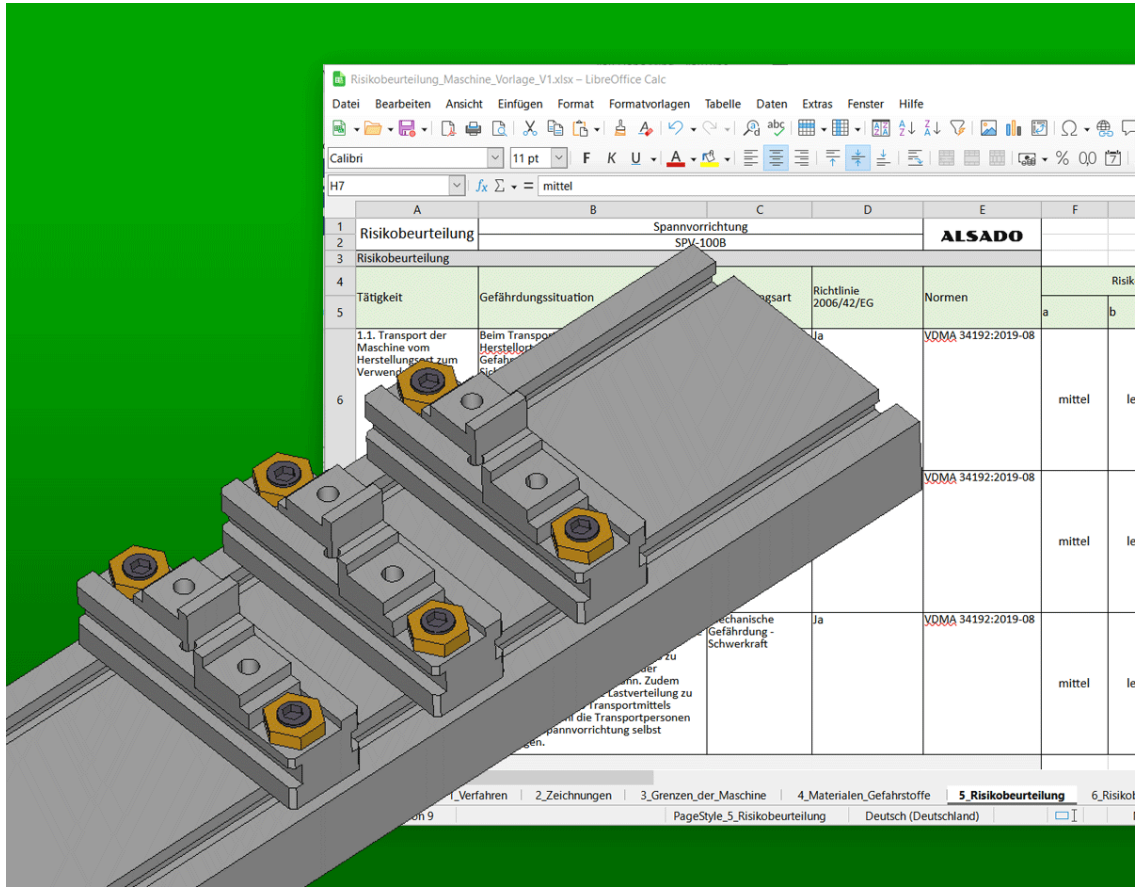
Product safety (CE) in LibreOffice Calc

- Create an overview of all possible product safety directives from the european union for your selected product concept
- Evaluate each one of them and decide if ist applicable. Each directive has a defined scope, written at the beginning of the directive document.
- Get an overview of (harmonized) standards and decide for each one if it is applicable for your product concept
- Create a risk assessment based on ISO 12100

Software used: LibreOffice Calc



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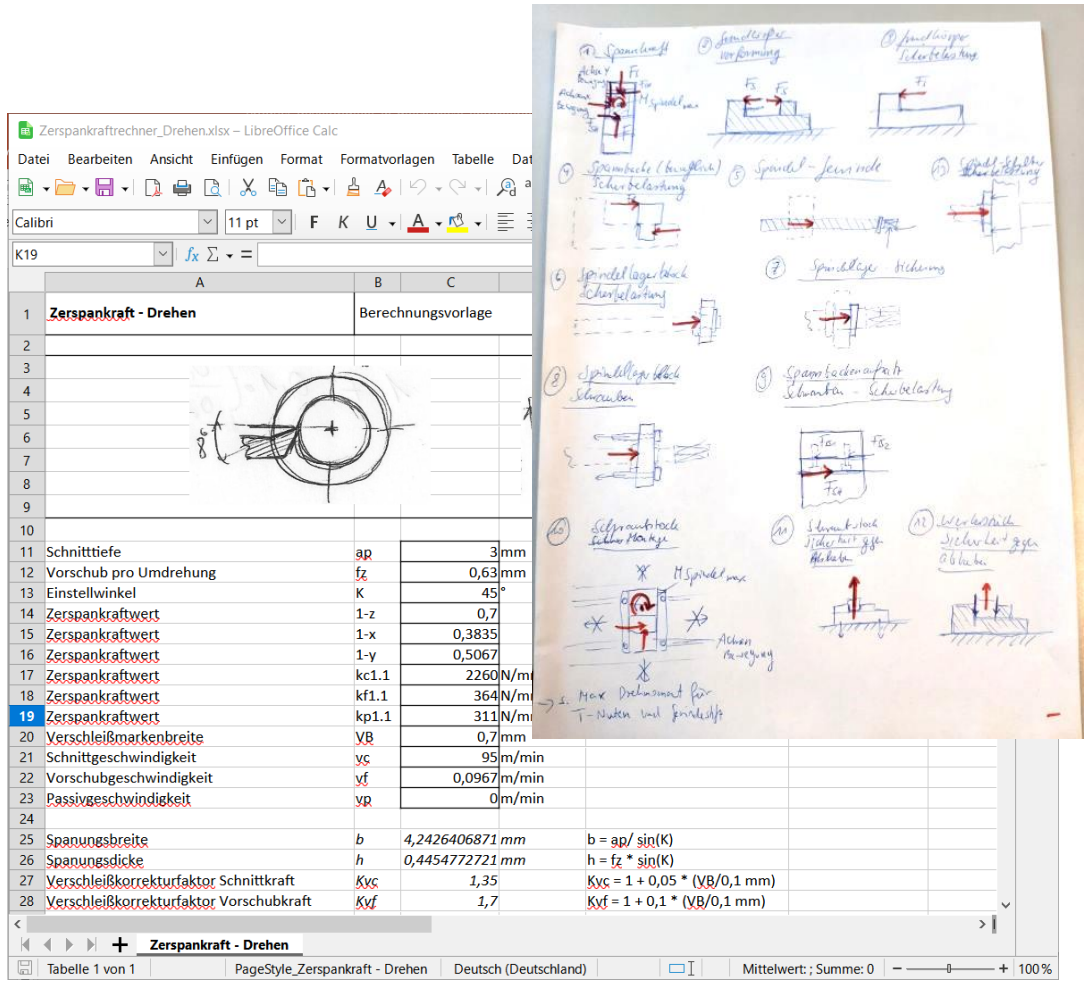
Preliminary design in LibreOffice Calc

- Determining as many details of the product based on functional (product concept) and product safety (risk assessment) requirements
- Determine properties of product by calculations or decision trees:
  - Factor of safety
  - Forces
  - Dimensions
  - Tolerances
  - Surface roughness
  - Temperature
  - Time
  - …

Software used: LibreOffice Calc



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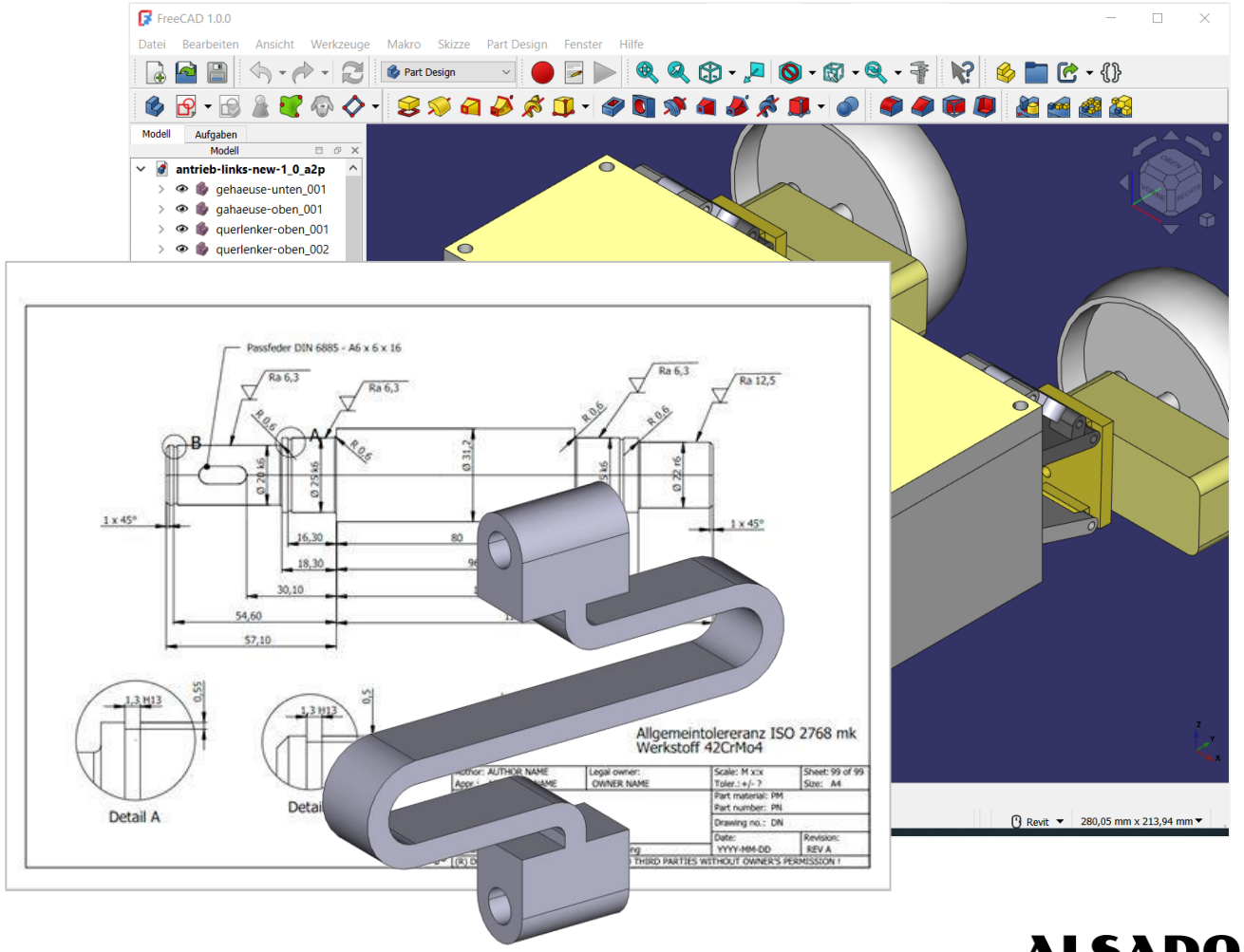
Detailed design in FreeCAD

- Based on preliminary design, create a virtual representation of the final product.
- 3D CAD
- Technical drawings
  - Single part manufacturing drawing
  - Assembly drawings
- Export STEP, DXF, PDF

Software used: FreeCAD



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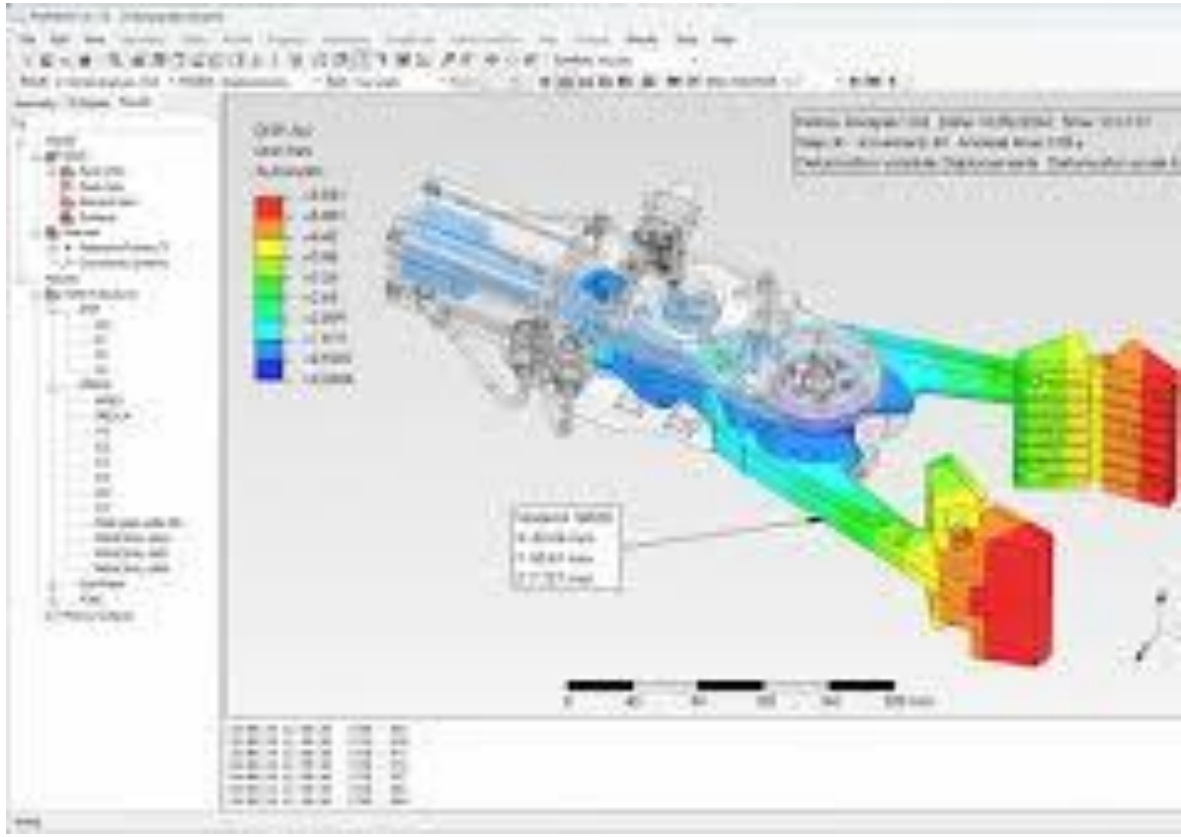
FEM simulation in PrePoMax

- For all parts that cannot be calculated analytically in the preliminary design step a FEM simulation needs to be performed:
  - Boundary conditions
  - Mesh
  - Solver

Software used: PrePoMax



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On-premise product-lifecycle-management using Subversion

- Folder structure Versioning and user management with SVN (SVN Server, SVN client, Lock)
- Centralized server with server hardware and clients on same local network
- Redundant raid storage
- Redundant power supply: Uninterruptable power supply (UPS)
- Store data externally in regular time intervalls

Software used: VisualSVN, TortoiseSVN

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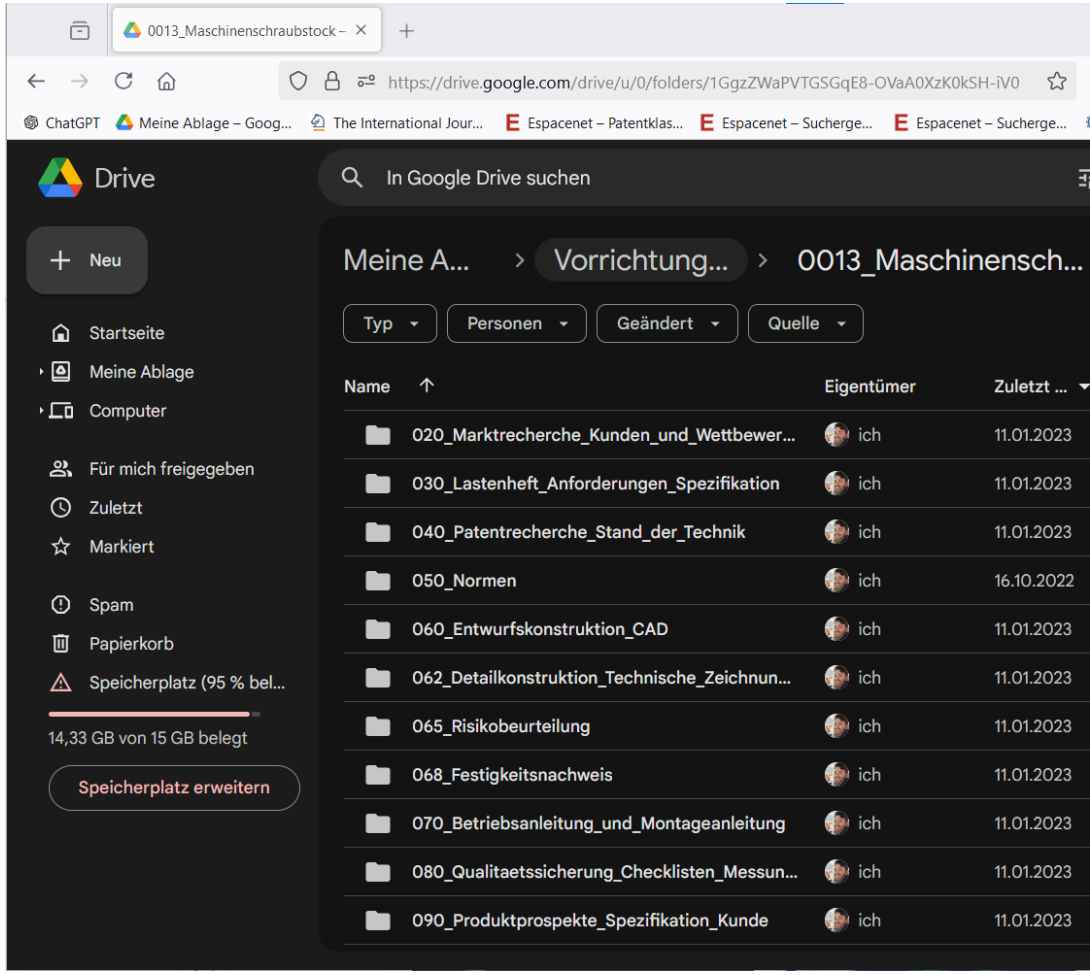
Alternative: Google Drive

- Same folder structure
- Integrated versioning
- User management with access rights
- Locking and unlocking files
- Centralised Cloud storage – free plan is good enough for most projects
- Might not be suitable for everyone because of potential data breaches

Software used: Google Drive



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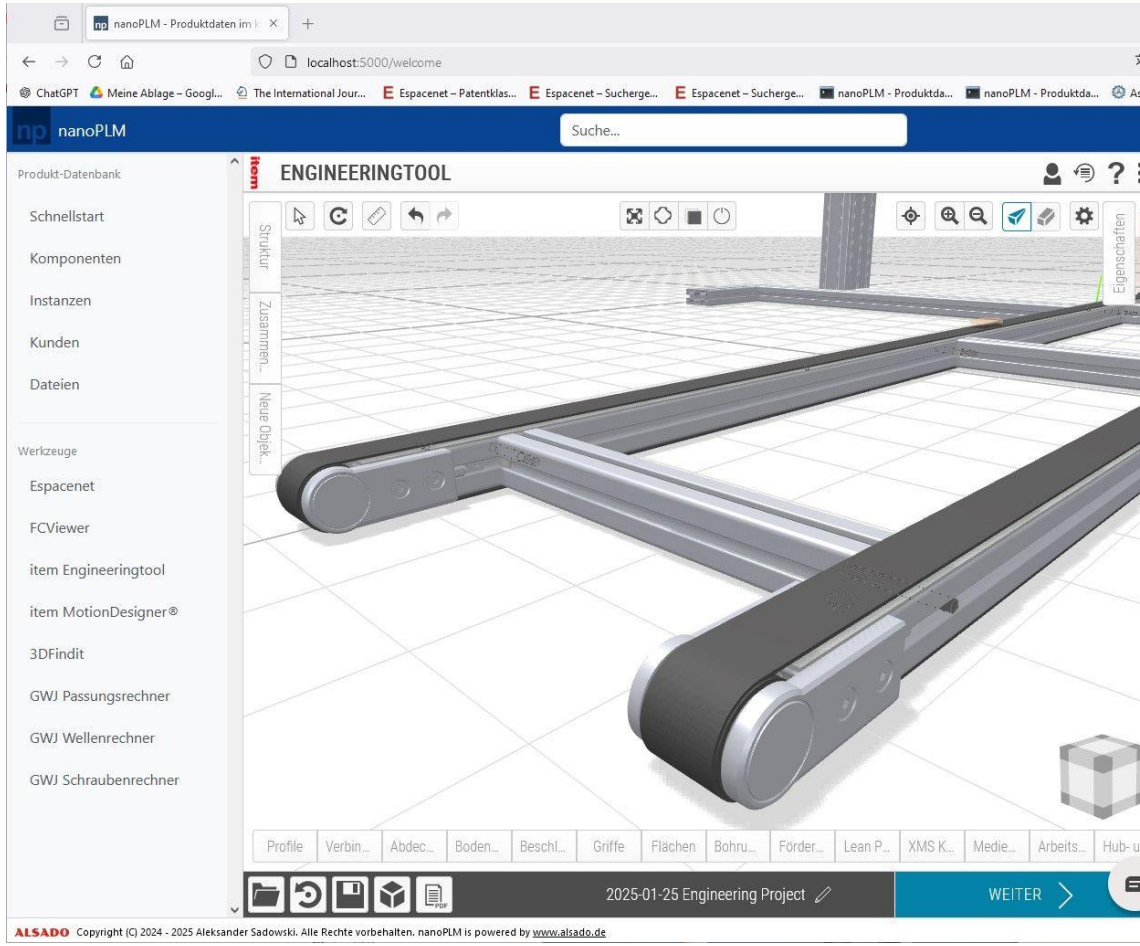
Benefits of a PLM solution

- File structure and consistency
- Versioning
- User management
- Fast search
- Workflow templates
- Integration tools for automating tasks throughout the product lifecycle, including the product development process

=> Development of the open-source PLM **„nanoPLM“**



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Contact

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