Algorithm-boosted design of boiler buildings

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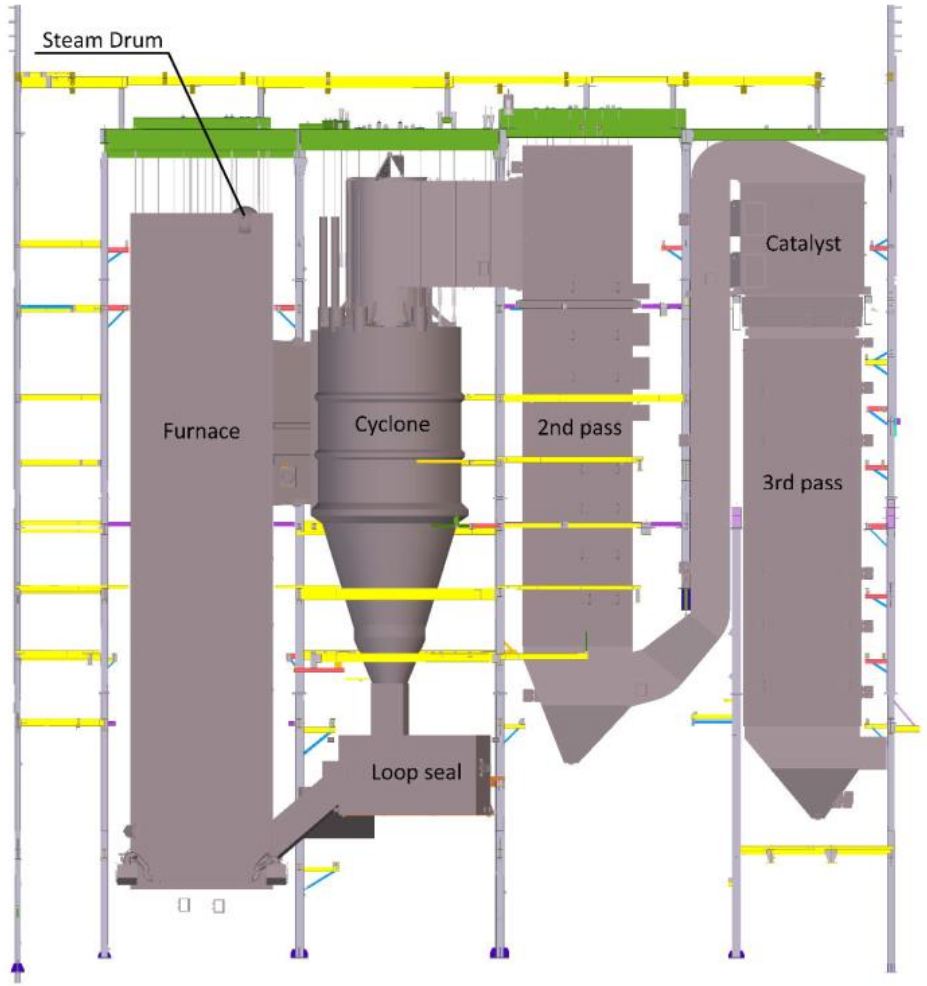
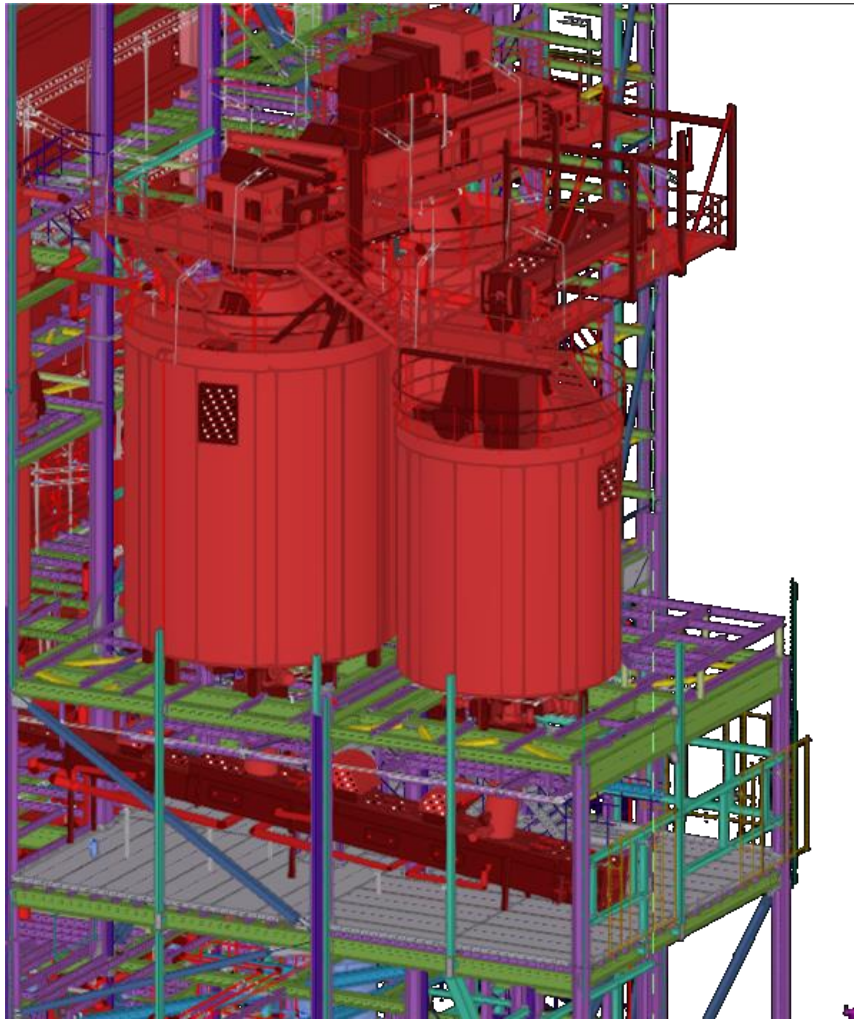
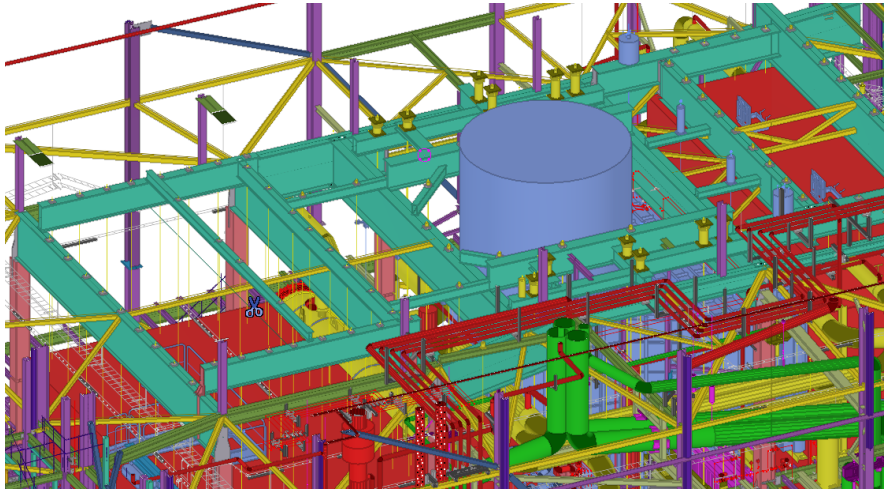
Boiler building

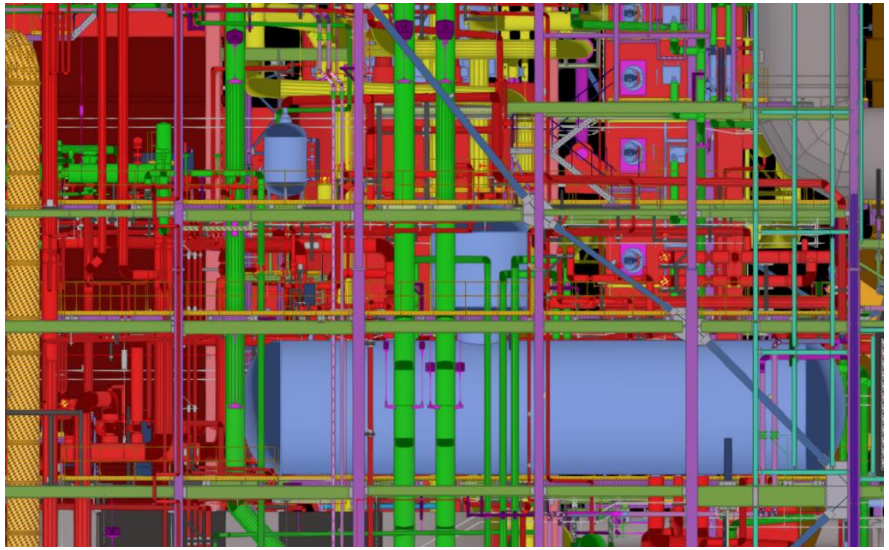
- Boiler buildings provide heat and elecricity for society or work as an energy source for mills and factories.
- Boiler buildings are remarkable export products for the Finnish economy.
- The heart of the boiler building is the pressure body, consisting of furnace and attached equipment for treating the exaus gas and collecting the heat in several steps.
- In order to control the thermal expansion and stability of the pressure body structures, they are hanged from top with heavy steel beams.
- Our job in Sweco is to **design the steel structure** supporting the pressure body and all the other equipment and pipings



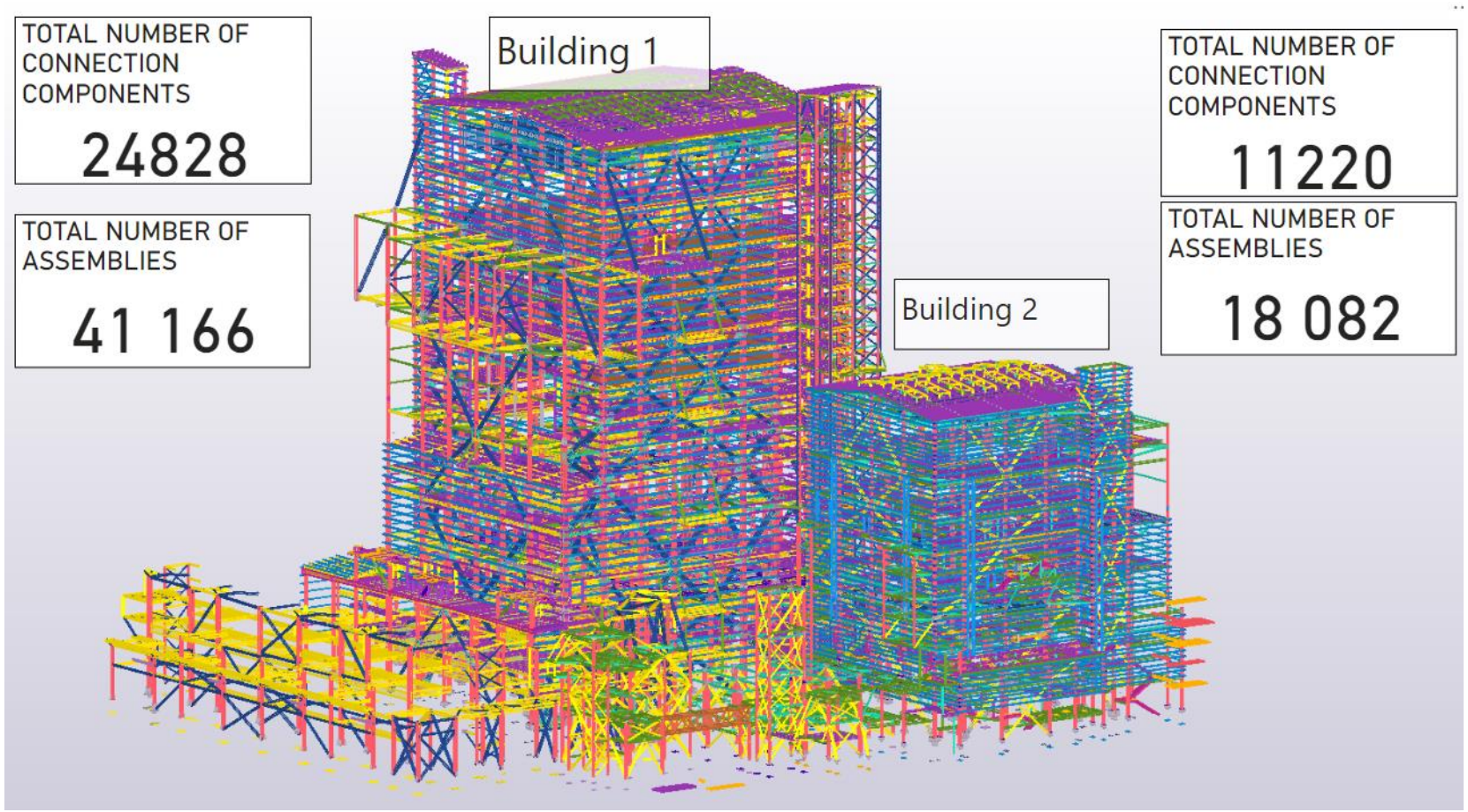
Peak inside – Supported equipment



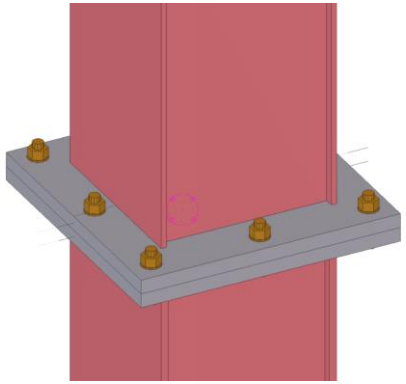


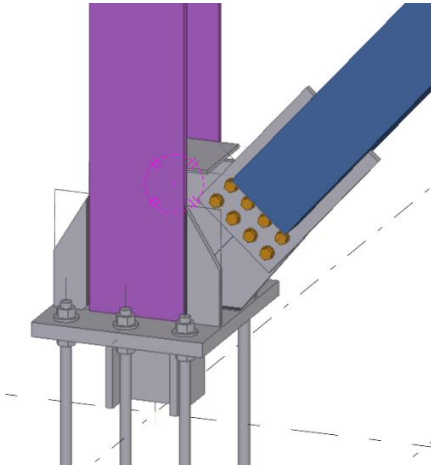


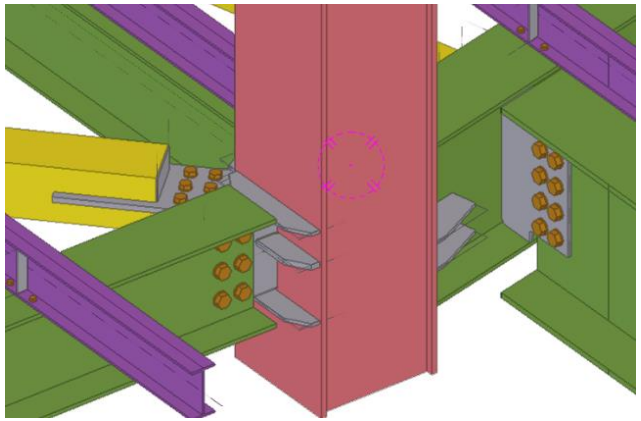
Statistics from a project with two boiler buildings

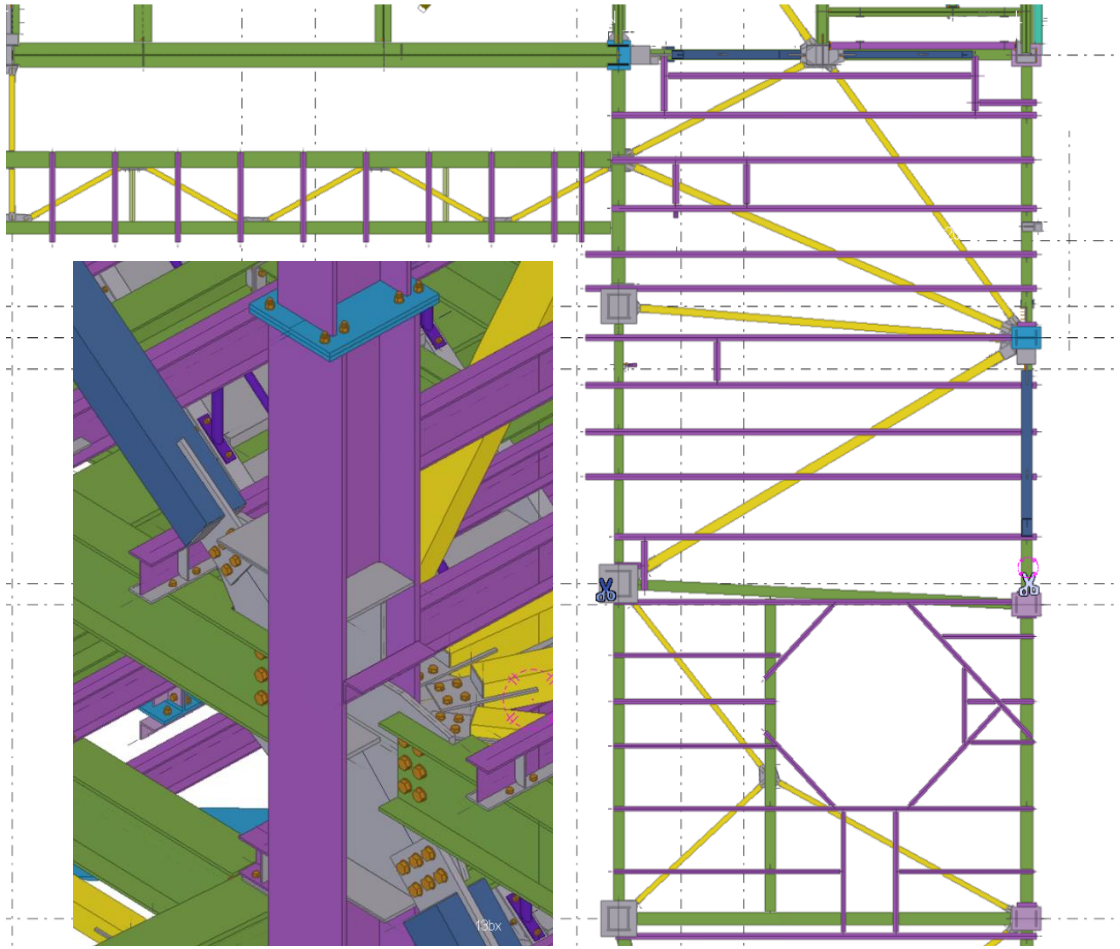


Platform structures and connection details









The challenge for AI & Design Algoritms

- Fully parametric mathematical description of the structure is not possible
  - The structural system is complex and the space is limited to avoid collisions with the equipment of piping.
  - Fitting the structure and equipment requires seamless discussion with the boiler building supplier and strucural engineer.
  - The connections details are complex, due to the reason that there can be even 10 or more beams, columns or braces intersecting at the same location.
- Tight space, difficult to vary/compare different structural solutions with algorithm (which is usually considered as the most valuable benefit of design algorithms)
  - Most of the decisions considering strucutre locations already done when the structural engineering

Possibilities of AI & Design Algorithms

- **HUGE** volume of individual structural objects
- **HUGE** amount of load data to be processed and embedded in structural calculations

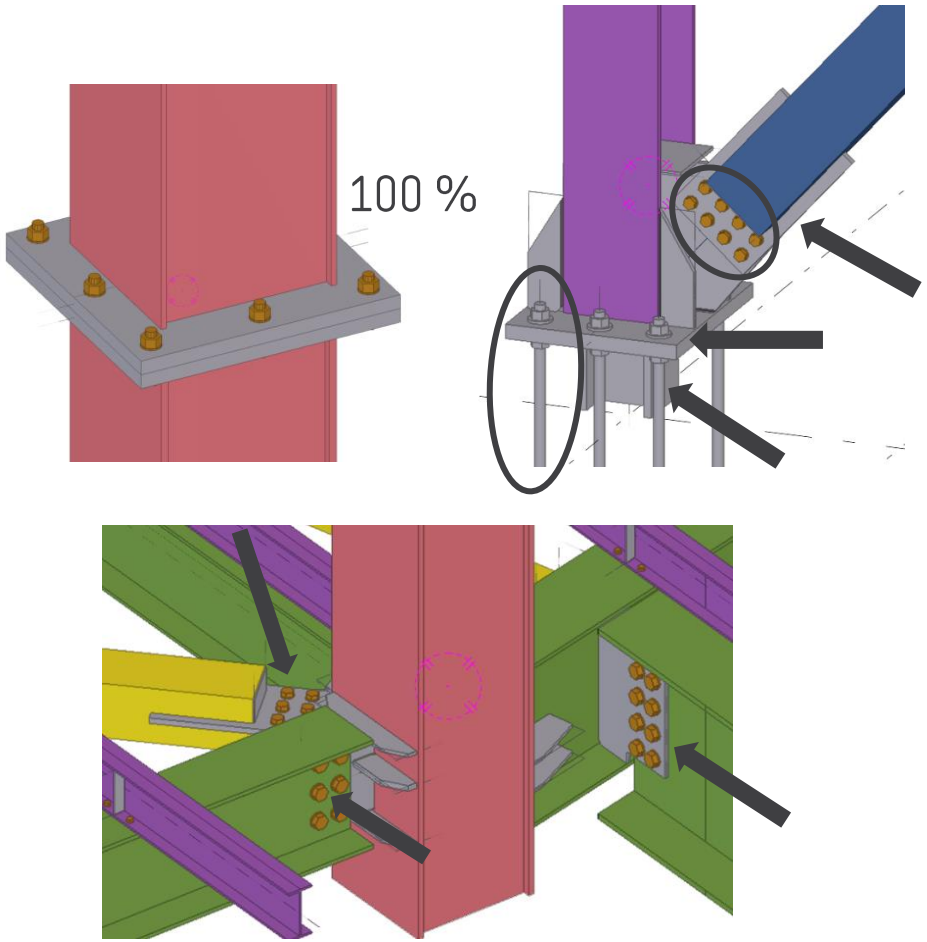
- Repetitivines between projects, several projects to be done with the same customer
  - The syntax of the initial data is standardized
  - The developed tools are reused

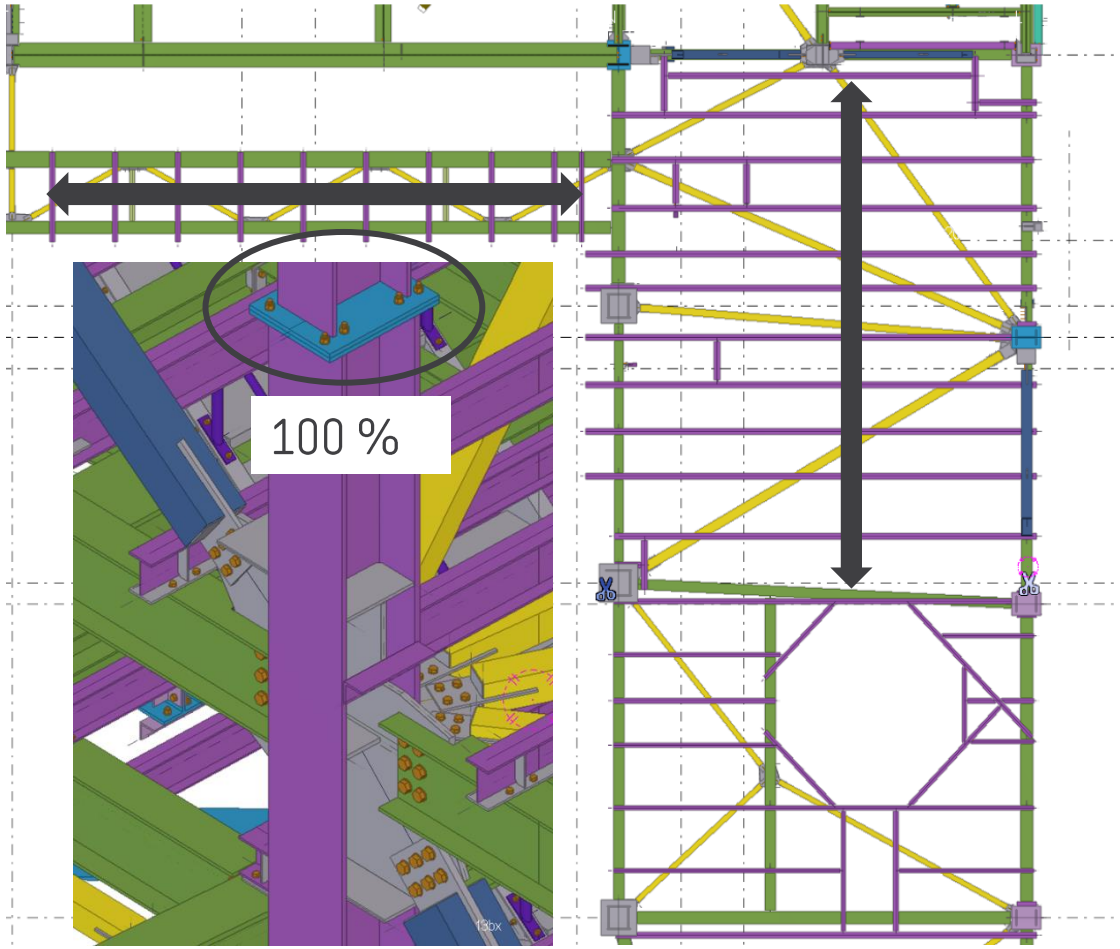
- Intergrating structural analysis model (FEM) and its results with product model (Tekla Structures) - automatic data transfer

- Hectic schedules. Speeding up the design.

- Possibility for data mining of old BIM models for past 10 years (or more)

Platform structures and connection details – Ideas for automation

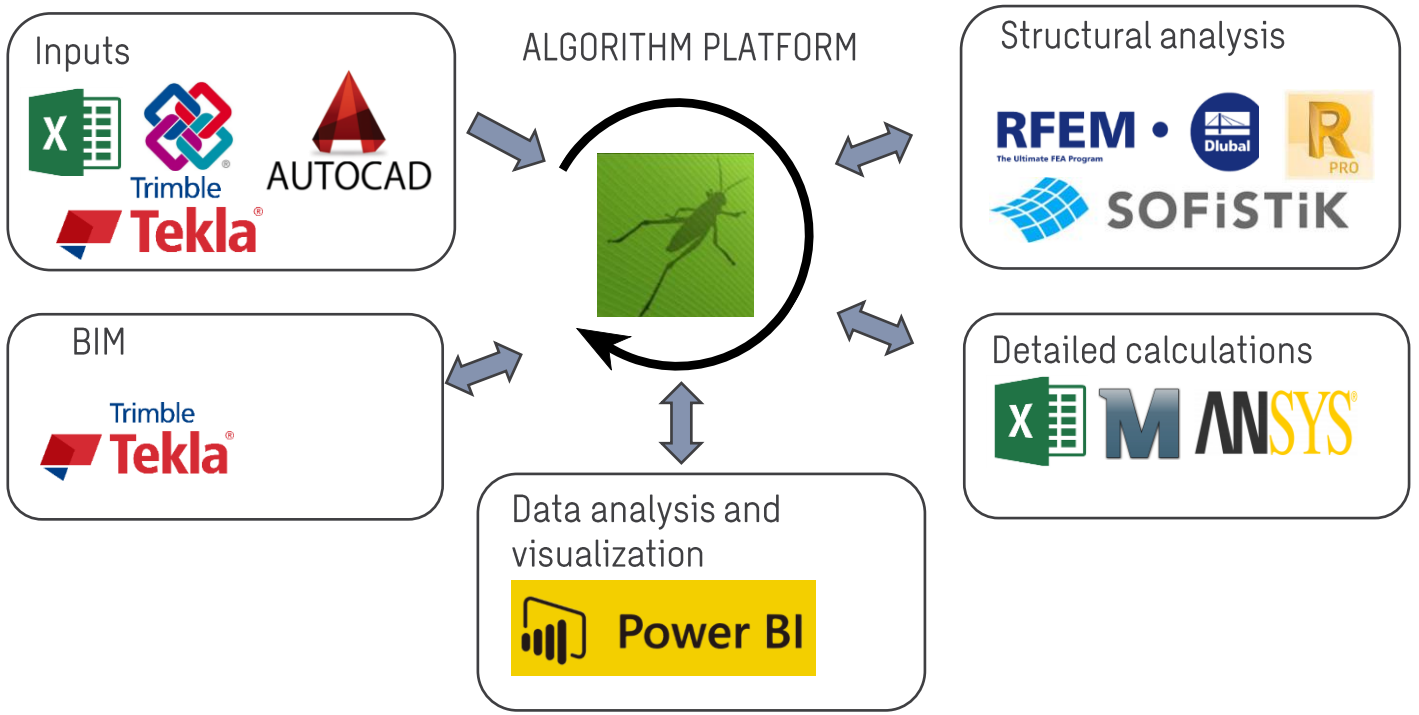




Computational Designer

”A project specialist, who combines programming with structural engineering, automating the data flow between design softwares, making project business more efficient.”

- A new role in the field of structural engineering
- Responsible for parametric tool box and automation algorithms applied in the project
- Right hand of the project manager, bringing the latest design technology into practice
- Involved in the project kick off meetings in order to harmonize the input data from customer or other disiplines in a computable syntax



Summary

- Stuctural systems are complex, 100 % algorithm-controlled output will never be possible
- However, there's lot of repetitivenes in and between projects
- Individual project steps & task can be significantly speeded up with algorithms. Even small automation things matter, due to the huge volume of designed structural objects.
- **Algorithms can be used to generate design suggestion or billet ("aihio") which is checked & finished with human intelligence**
- Computational designer controls the algorithms and dataflow between softwares
- Algorithm-aided pre-engineering (Structure modeled + FE model + foundation loads) was speed up from two weeks to 3 working days (Master's thesis: Algorithm-aided pre-design of boiler buildings, Janne Koivuniemi 2021)

- People behind the material shown in this presentation
  - Janne Koivuniemi
  - Riku Höyhtyä
  - Timo Ketola

THANK YOU!

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