FAST MOVING TECHNOLOGY

STÄUBLI

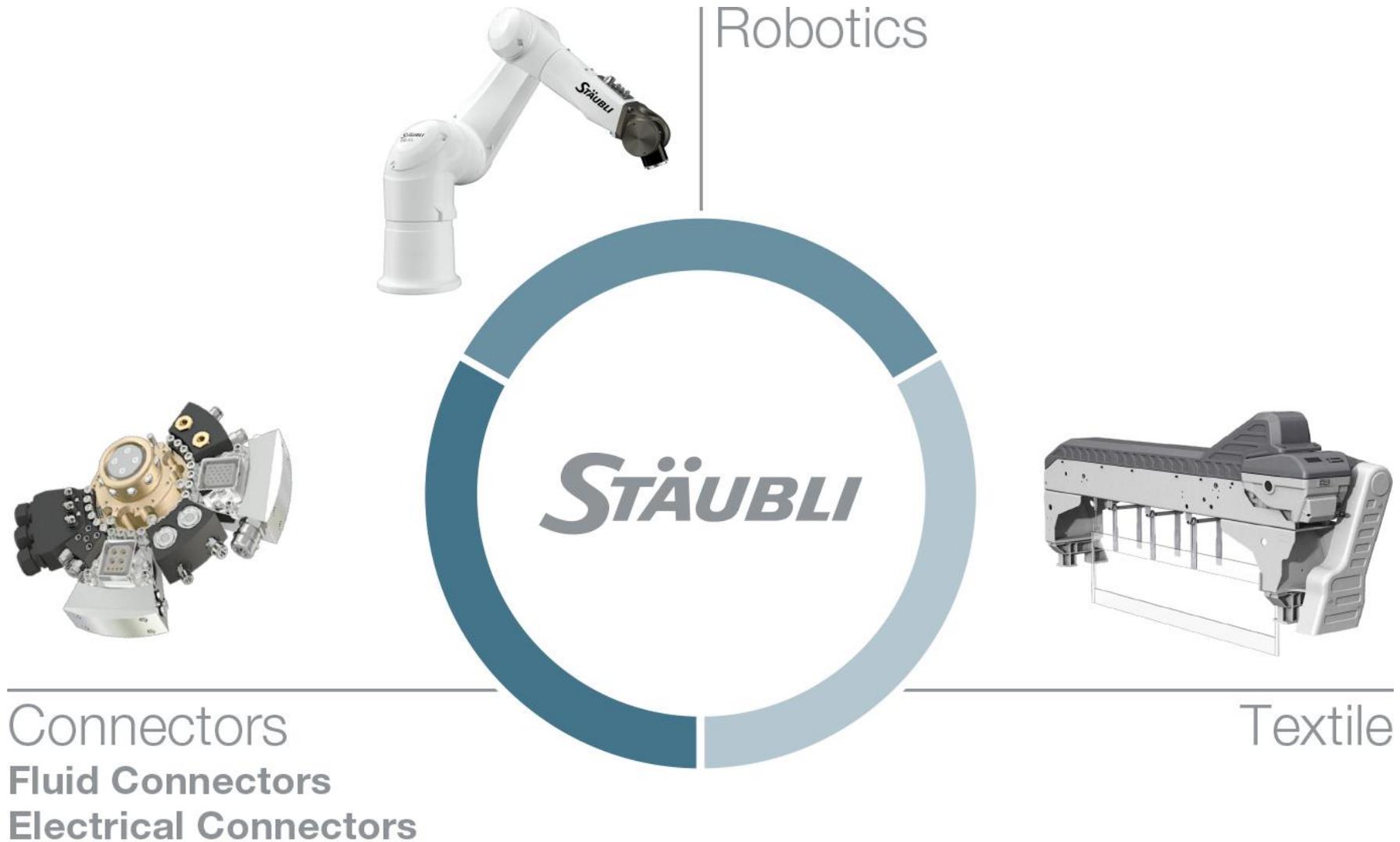# On the way to more robot transparency

10. Robotics Kongress | 10.02.2021 | Günter Heinendirk

Global presence of the Stäubli Group

5500
employees
worldwide

2000
Sales & customer
service engineers

Business
units in

29
countries

Founded

1892
in Horgen, Switzerland

1.3
billion Swiss francs
(CHF) turnover

20
industrial
segments

14
industrial
production
sites

600
R&D specialists
and application
engineers

2100
granted or pending patents

Three activities – four divisions

Robotics

STÄUBLI

Connectors

Fluid Connectors
Electrical Connectors

Textile

High performance and reliability

Our Textile products and services range from

- **Automated weaving preparation systems,**

- **Shedding solutions for frame weaving** and **Jacquard weaving** to

- **Carpet weaving systems,**

- **Weaving systems for technical fabrics,**

- **Automation solutions for sock knitting machines**

as well as **spare parts** and **customer training**.

Reliability at every connection, versatility for every application

Stäubli Fluid Connectors product range covers:

- Quick-release couplings

- Energy centralized connections

- Robotic tool changers

- Quick mold change solutions for the plastics industry including :

    - mold clamping solutions

    - tool loading tables and trolleys

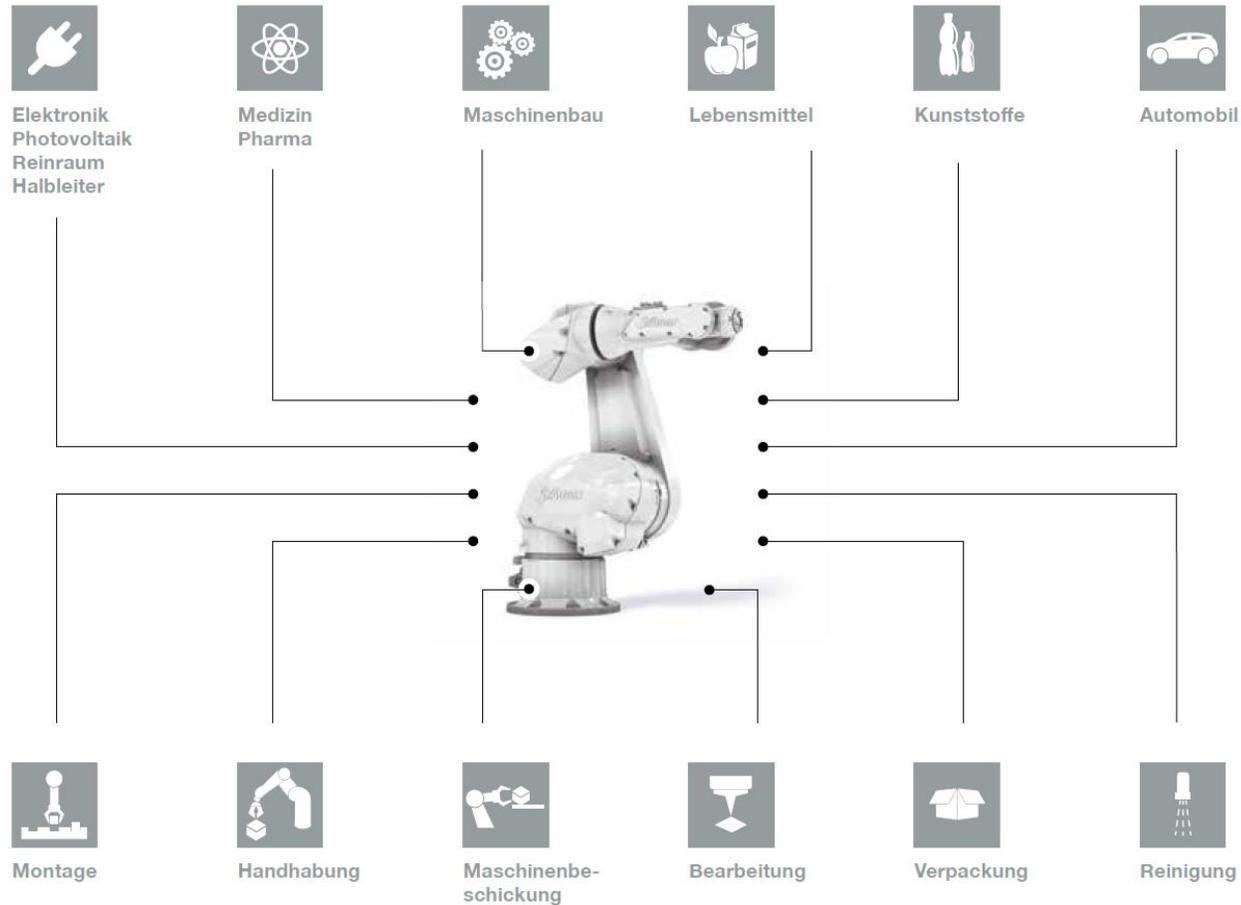- Our solutions are designed to ensure cost efficiency and operators' safety.
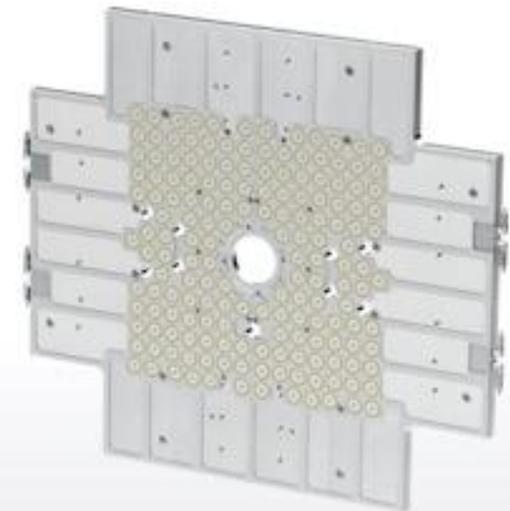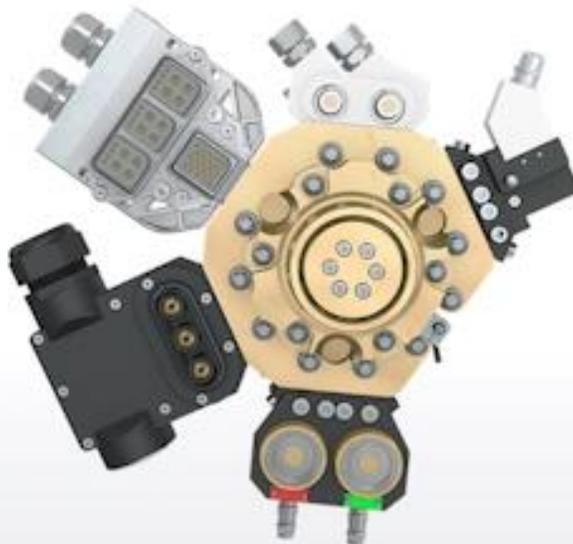
Solutions tailored to each industry

Stäubli Electrical Connectors cover the whole range from single parts to highly complex systems

- MULTILAM contact technology

- designed for reliability and long service life

- outstanding electrical and mechanical properties

- fit for harsh environments

- to transmit power, data, signal and fluids

Robotics
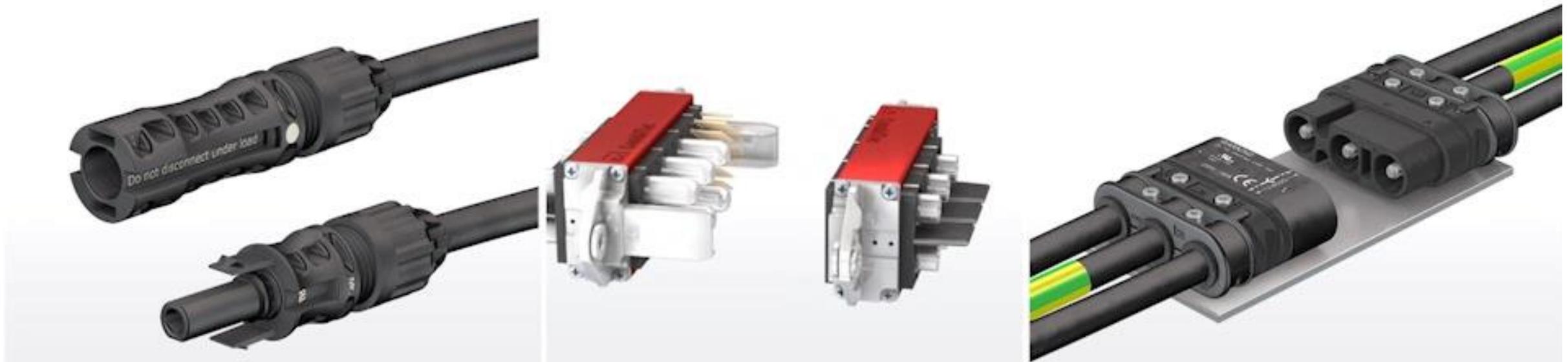
Stäubli-Robots guarantee high process reliability and productivity gains in all industries and application areas:

Elektronik
Photovoltaik
Reinraum
Halbleiter

Medizin
Pharma

Maschinenbau

Lebensmittel

Kunststoffe

Automobil

Montage

Handhabung

Maschinenbe-
schickung

Bearbeitung

Verpackung

Reinigung

The 5 W´s

Which data?

Why do we do this?

Where to store?

Who are the Stakeholder?

What to do with it (how to evaluate)?

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Business Models

For our customers

- Evaluation of the robot status (lifetime)

- Reduction of downtime

- Indicators for quality of own products

- Maintenance and exchange parts on demand

- New pay per XXX models

- Cycle time optimization

For Stäubli

- Obtaining information on operating conditions for R&D

- Quality control

- Improved service deployment planning

- Better adapted warranty conditions

- New pay per XXX models

The 5 W´s

Which data?

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Where to store?

Who are the Stakeholder?

What to do with it (how to evaluate)?

Which group in the company is involved?
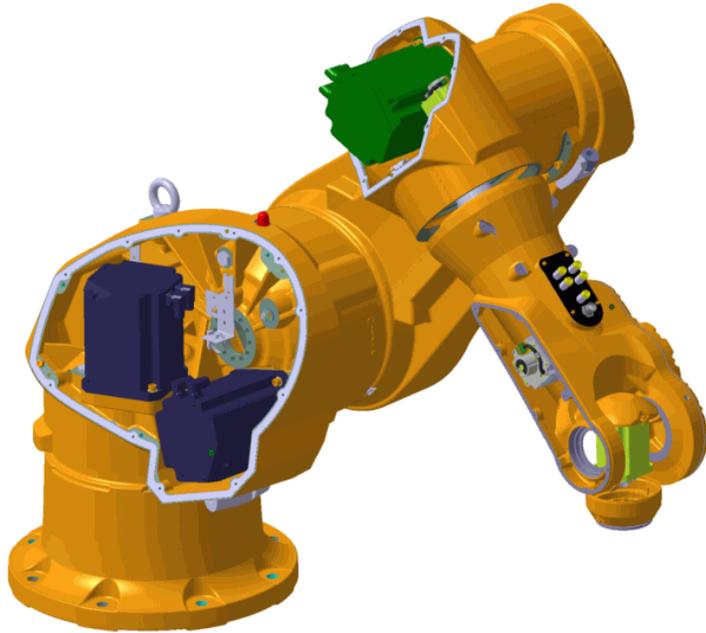
At customer side

- Maintenance

- Production planning

- Quality department

- Purchasing department

- IT

At Stäubli

- Sales

- Service

- Quality department

- R&D

- Support

Infrastructure

Administration — IT network

Management — Planning network

Team leaders

Production network
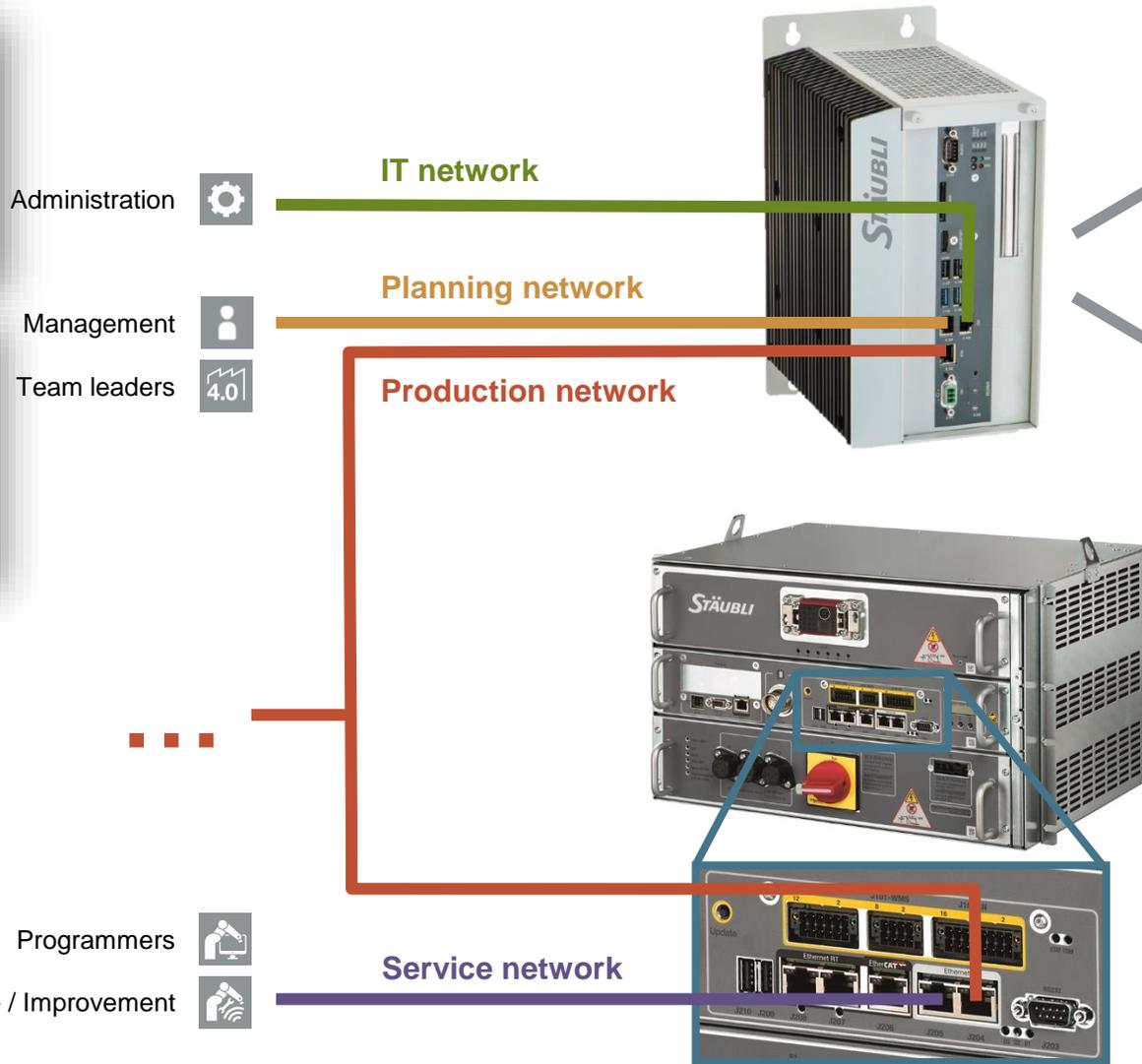
Programmers

Maintenance / Improvement — Service network

Big / Live Data Customer

Big / Live Data Stäubli

The 5 W´s

Which data?

Why do we do this?

Where to store?

Who are the Stakeholder?

What to do with it (how to evaluate)?

Which data is interesting?
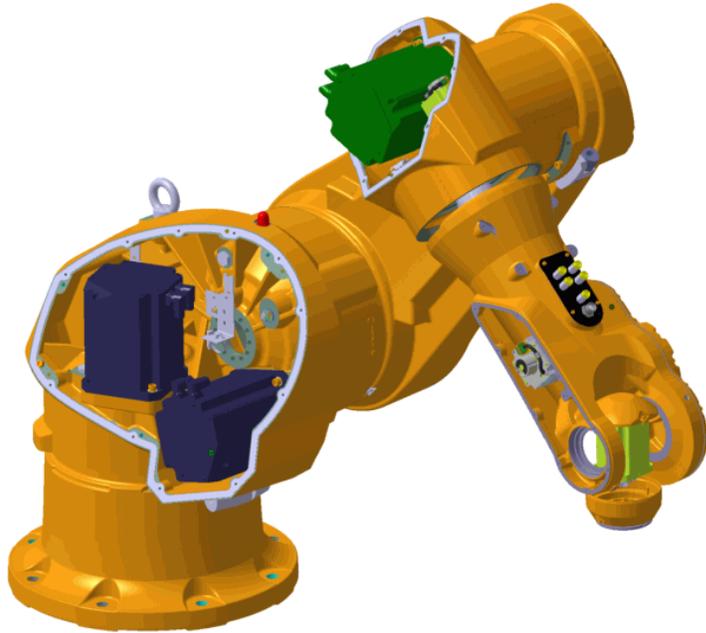
- Serial numbers of all components

- Payload of the robot

- Operating hours of the arm

- Commanded and actual positions of the joints

- Commanded and actual currents of the joints

- Serial numbers of all components

- Operating hours of the controller

- Software Versions (operating system, tuning)

- Temperature (amplifier, CPU, controller)

- Log files

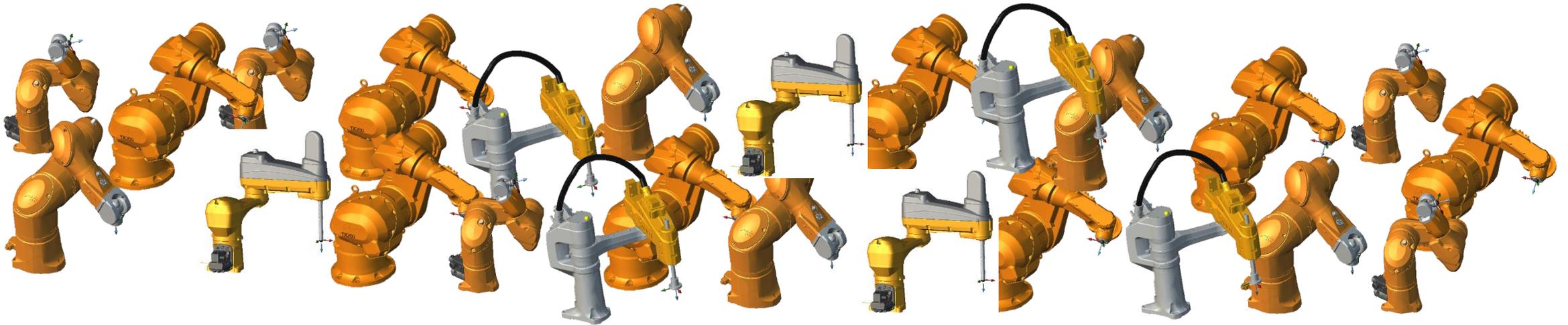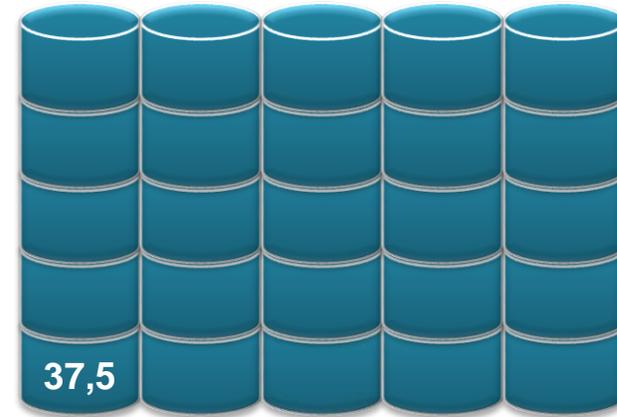- Application specific information

- Inputs and outputs

The 5 W´s

Which data?

Why do we do this?

Where to store?

Who are the Stakeholder?

What to do with it (how to evaluate)?

Quantity of data

- ✖ Serial numbers of all components
- ✖ Payload of the robot
- ✖ Operating hours of the arm
- ✔ Commanded and actual positions of the joints
- ✔ Commanded and actual currents of the joints

- ✖ Serial numbers of all components
- ✖ Operating hours of the controller
- ✖ Software Versions (operating system, tuning)
- ✖ Temperature (amplifier, CPU, controller)
- ✖ Log files
- ✖ Application specific information
- ✔ Inputs and outputs
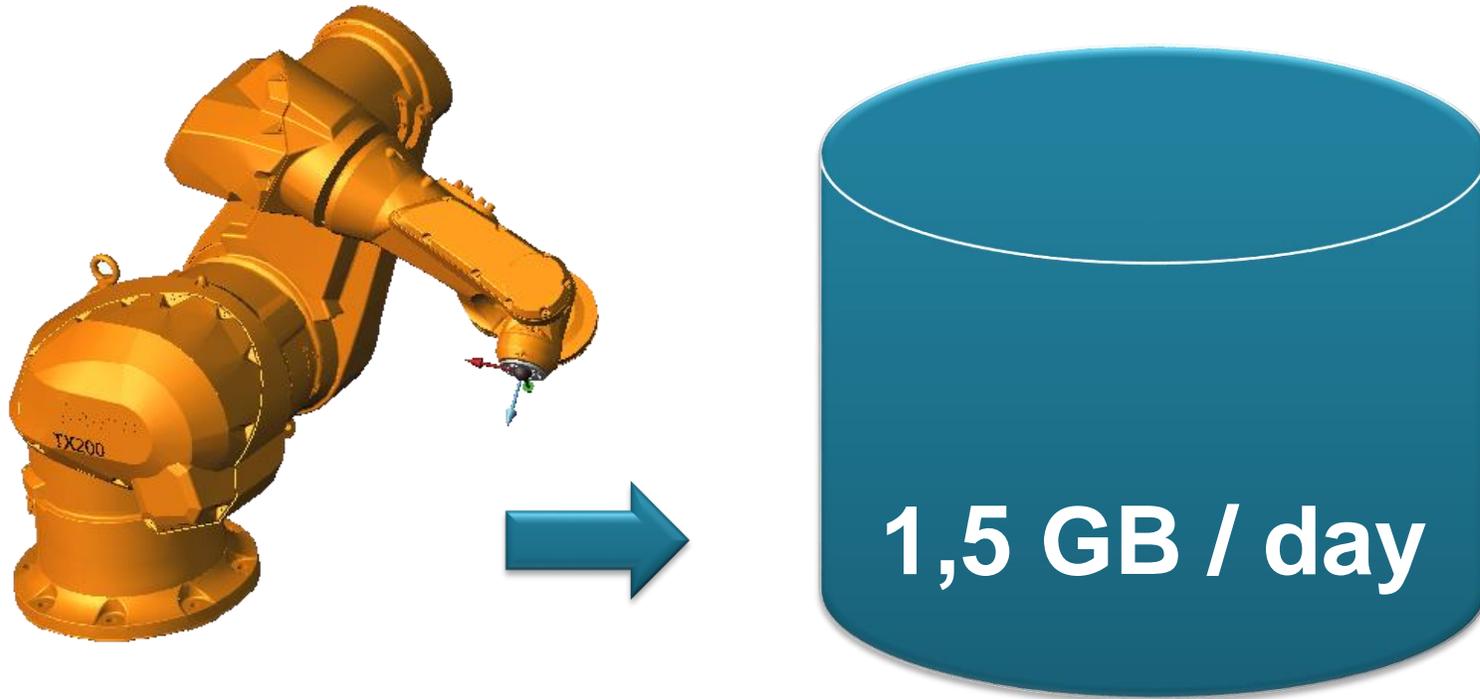
Edge or Cloud ?

1,5 GB / day

37,5 GB / day
with 25 robots

37,5

The 5 W´s

Which data?

Why do we do this?

Where to store?

**W**ho are the Stakeholder?

What to do with it (how to evaluate)?

Data reduction

- 37.5 GB per day cannot be written to the cloud via the Internet connection

- For the first evaluation **Edge** is the right place

- Data reduction

  – Data storage in the Edge **costs „little" money**

  – Data must be grouped in **same trajectories** and **examinded separately**

  – **Gradual** changes of a trajectory can be easily determined via average values per time unit

  – **Raw data** of a trajectory of a time interval (e.g. 1 hour) **should be kept** if the average value per time interval changes

  – Raw data of a trajectory must be kept if the average value differs **significantly** from others in the same time period

  – Remaining raw data will be deleted after 24 hours

    → **2 GB of data per robot on Edge Server**

Edge or Cloud?

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    → **2 GB of data per robot on Edge Server**

    → **70 MB / robot / day to the cloud**

➡ Edge **and** Cloud !!!

OptimizeLab

- Software for the analysis or evaluation of recordings

- Determines the current load on the robot based on the recorded data

- Provides valuable information that can be used to optimize a motion sequence

- Calculates an expected lifetime for each axis

OptimizeLab – How is my robot doing?

He´s running ...
He looks nice ...

So he is well ??

=
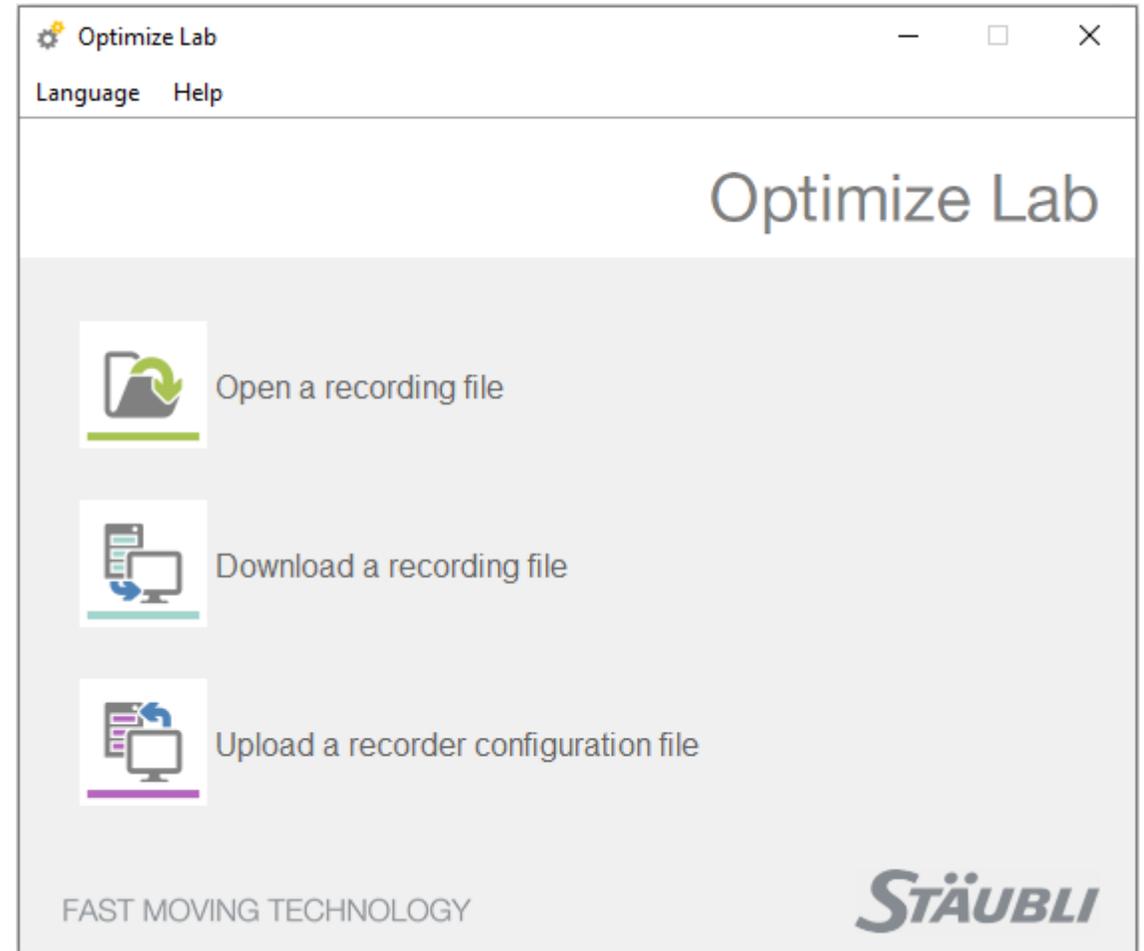
- Verification?

- Documentation?

- Warranty?

- Consequences?

- Downtime?

OptimizeLab – How is my robot doing?
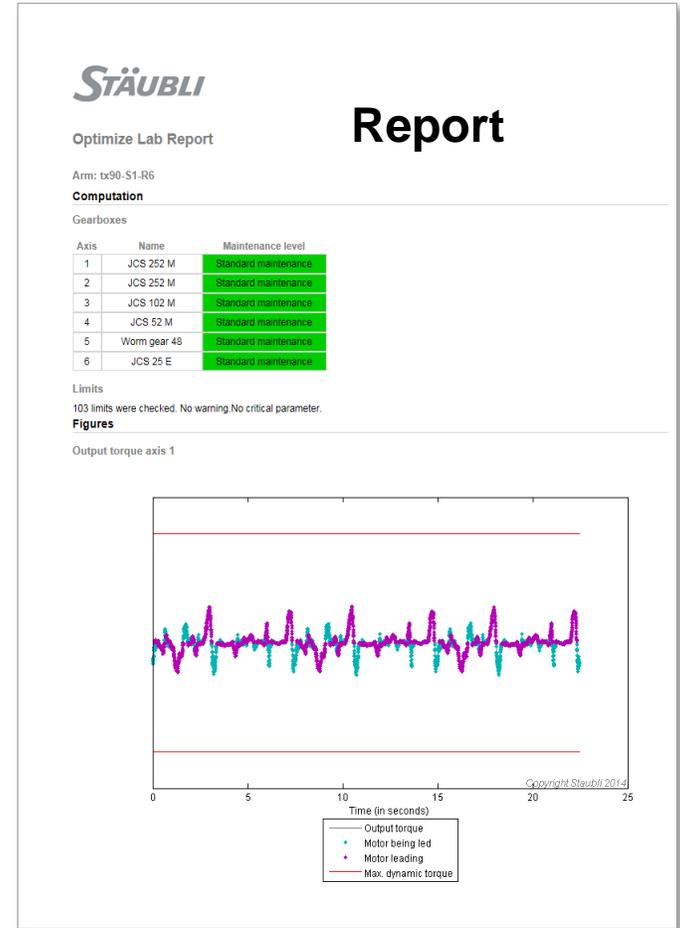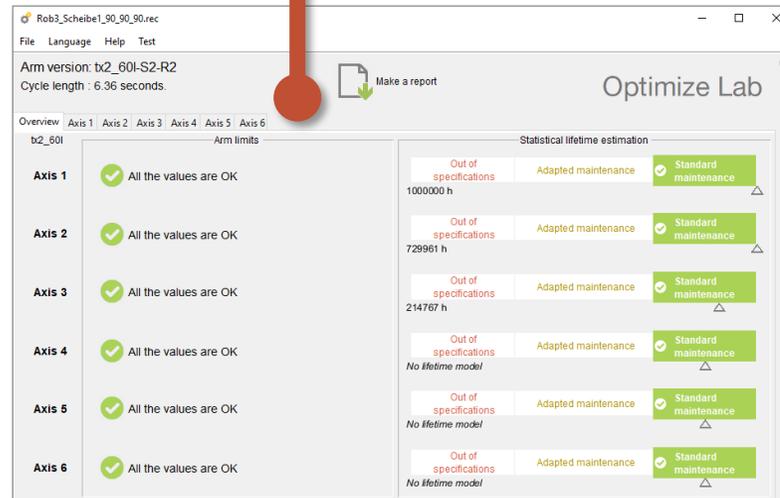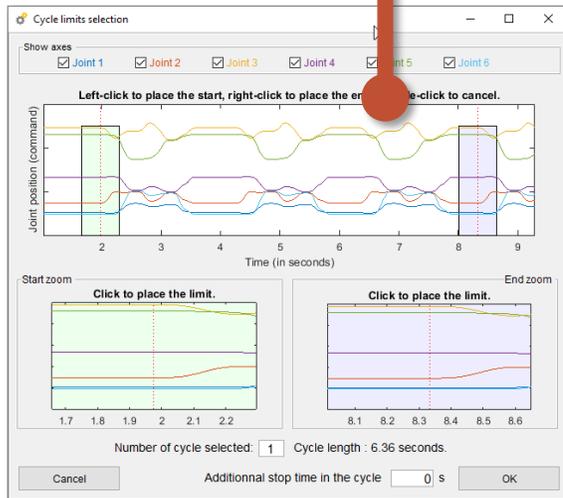
OptimizeLab – Monitoring

Regular analyses help to detect an overload of the robot at an early stage.

Reasons for this can be:

- Poorly taught positions
- Changes to the tool
- Changes in the process
- Changed dynamics
- Backlash
- Mechanical defects

Optimize Lab enables the documentation of the current state

These reports can be used for:

- The proof to the customer on acceptance of the machine
  („ The robot is operating within its specifications")
- As an incoming inspection of the customer when taking over the machine
- As proof in case of damage
  („ The parameters were changed after taking over of the machine")

OptimizeLab – Monitoring

OptimizeLab – Cycle time optimization

Evaluation of the Recordings

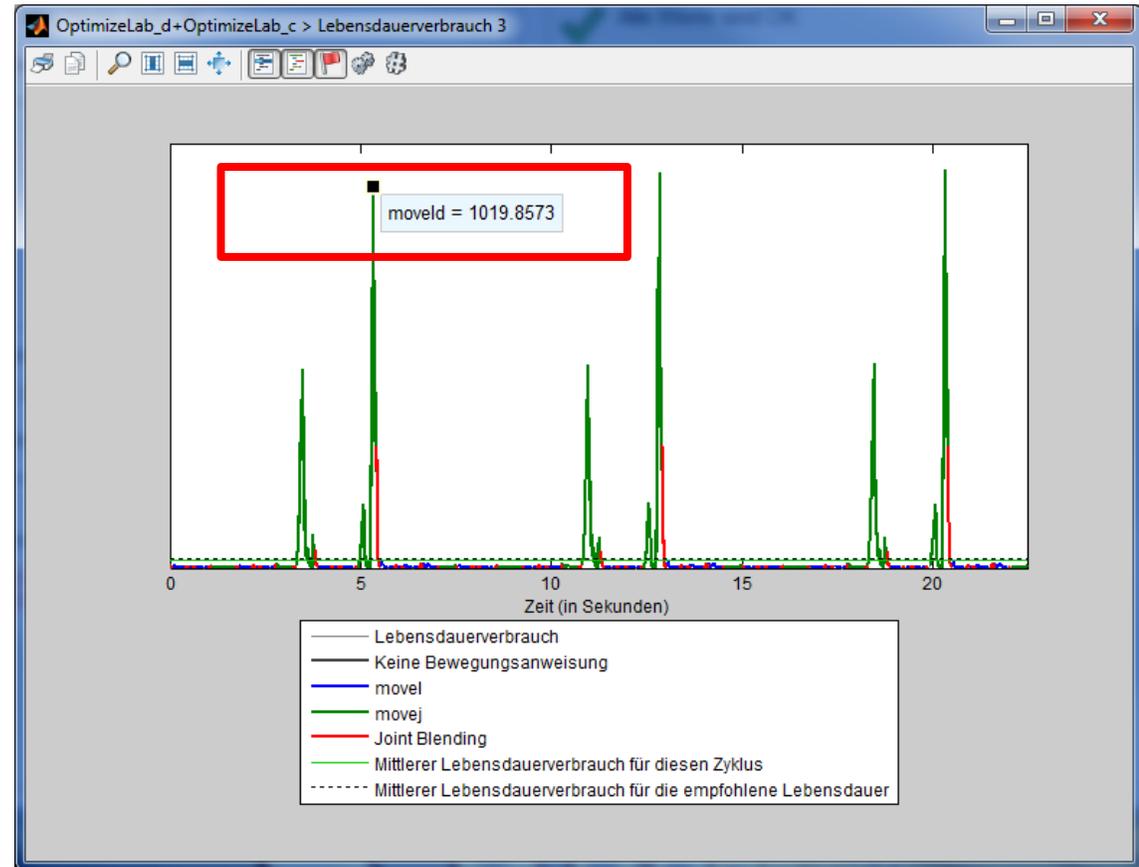Check the potential

Which joint is the most stressed?

OptimizeLab – Cycle time optimization

Evaluation of the Recordings

Check the potential

Which joint is the most stressed?

Detect stress peaks in the application.

Mathematical methods

- "Classical" mathematics offers valuable methods to generate knowledge from data.

- In combination with physical laws, this approach is definitely not "old style".

- OptimizeLab shows that very good results are achieved

- A neural network needs a lot of input data and a lot of training to get to the level of OptimizeLab.

- The "new" mathematics with many new approaches to pattern recognition is not a panacea but a perfect complement to the "classical" mathematics.

- The combination of both methods can do much more than the individual methods alone, especially for complex mechanical systems.
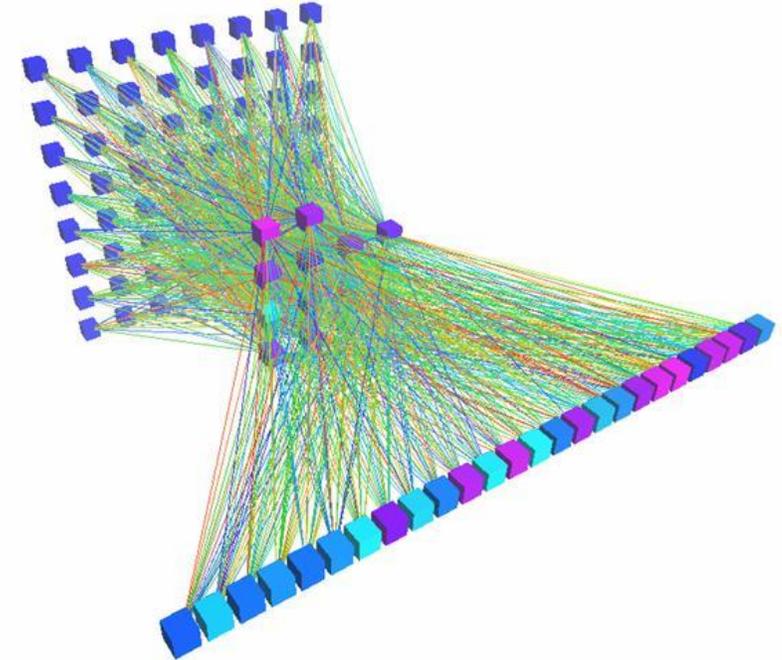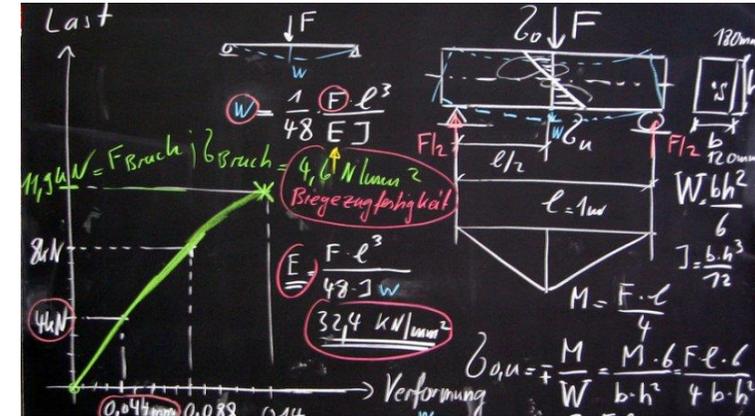
Summary

- The coordination of many different stakeholders in "Big Data" requires many discussions and persuasion efforts

- New business models can generate added value in many places - for all parties involved

- Big Data as a "quantity" is often underestimated

  - common mistakes are sorting out information too early due to capacity concerns (Network, Storage, CPU, …)

  - Meaningful data reduction is one of the most important tasks

- Combining "old" knowledge (e.g. physics, chemistry, mathematics, understanding of the production / product) with "new" mathematics often leads to better results

- Already trained neural networks can achieve good results in similar problems with much less data and time

- The goal today is not BigData but SmartData

- … and tomorrow not SmartData but „Knowledge"

Questions

FAST MOVING TECHNOLOGY

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Thank you for your attention!

www.staubli.com