

Improve machine performance through motion control

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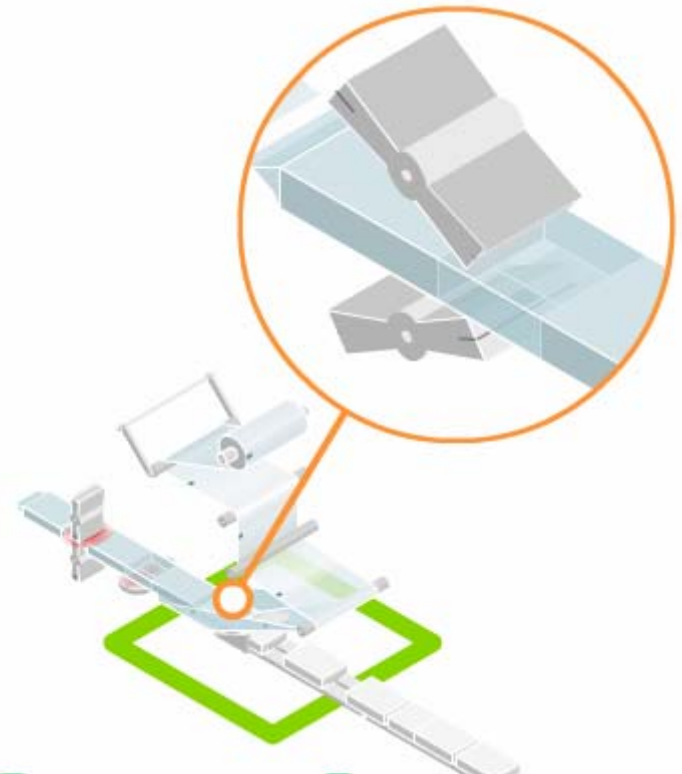
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[Machines]

NOW!

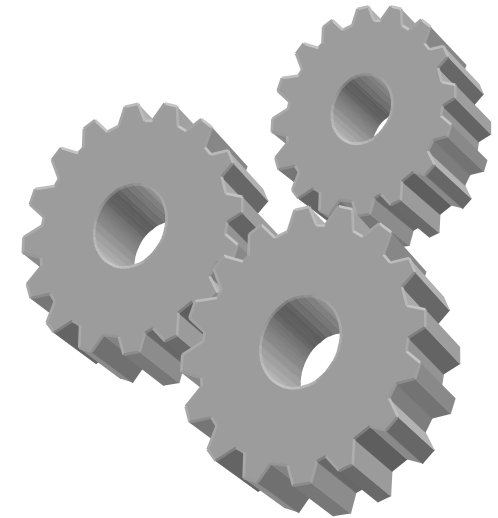
Example: Horizontal Flow Wrapper

- Foil has to be sealed and cut between the products
- Product gaps
- Different products
- Spacing between the products



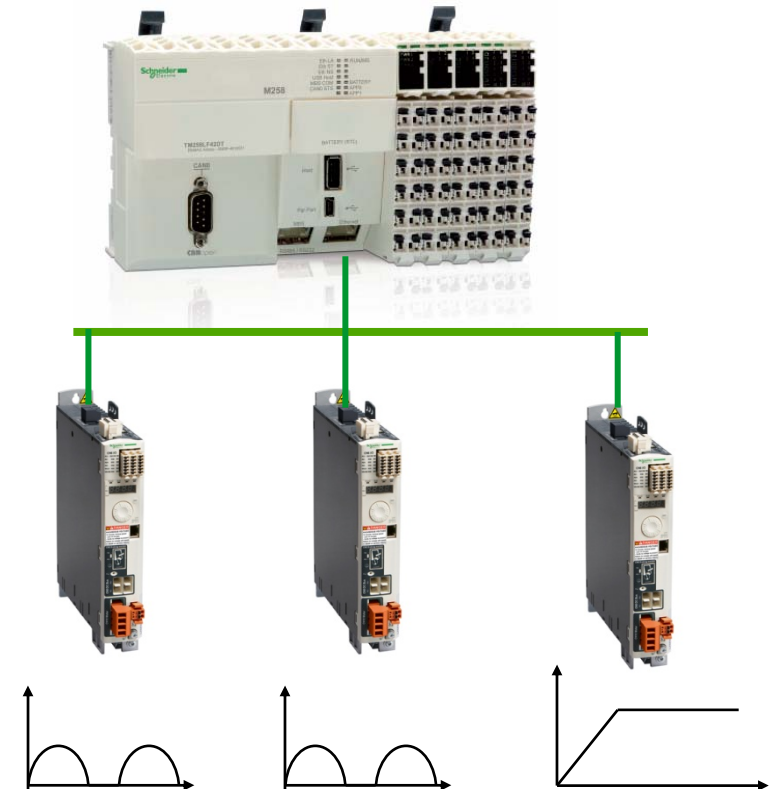
Approach 1: No motion control

- Tight synchronization of conveyor and rotating wheels
- Relies on fixed product positions
- Often high inertia for transmission systems
- No flexibility

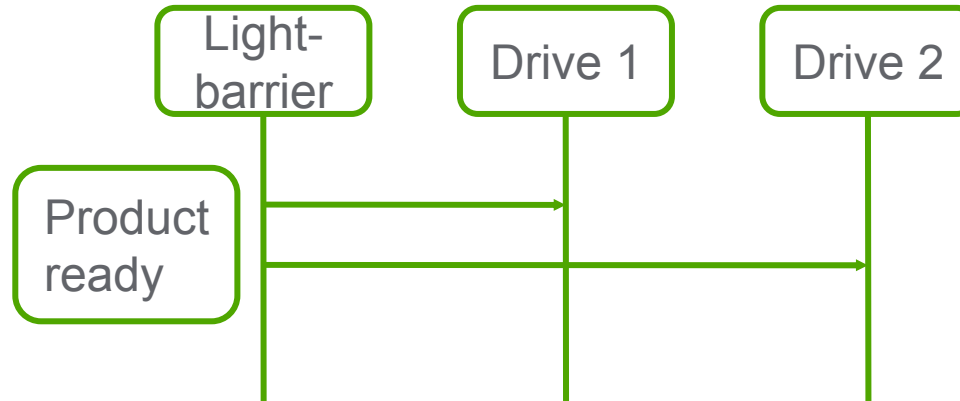


Approach 2: Coordinated motion

- Motion is distributed to several drives
- Motion profiles are handled by the drives
- PLC selects motion profiles and coordinates execution of these profiles
- By modifying parameters PLC can adjust profiles



Event driven programming



- Synchronization is based on events and timing
- Exceptions can lead to difficult to handle recovery scenarios as exceptions change timing
- Works with simple communication networks

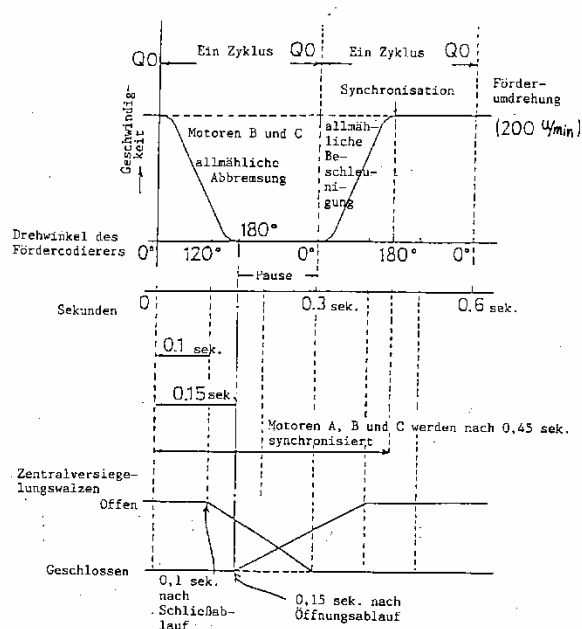
Typical example for coordinated actuators

ZEICHNUNGEN SEITE 5

Nummer: DE 38 40 231 C2
 Int. Cl. 5: B 65 B 57/12
 Veröffentlichungstag: 29. Juli 1993

FIG. 4

(Betrieb bei hoher Geschwindigkeit,
 200 Verpackungen/min; Zykluszeit: 0,3 sek.)



• Benefits according to patent claims:

- Less mechanical stress
- Higher speed

• Benefits are realized by

- Flexible acceleration profiles
- Multiple, coordinated servos
- Modification of motions in accordance to speed
- Sensors to adapt to product flow

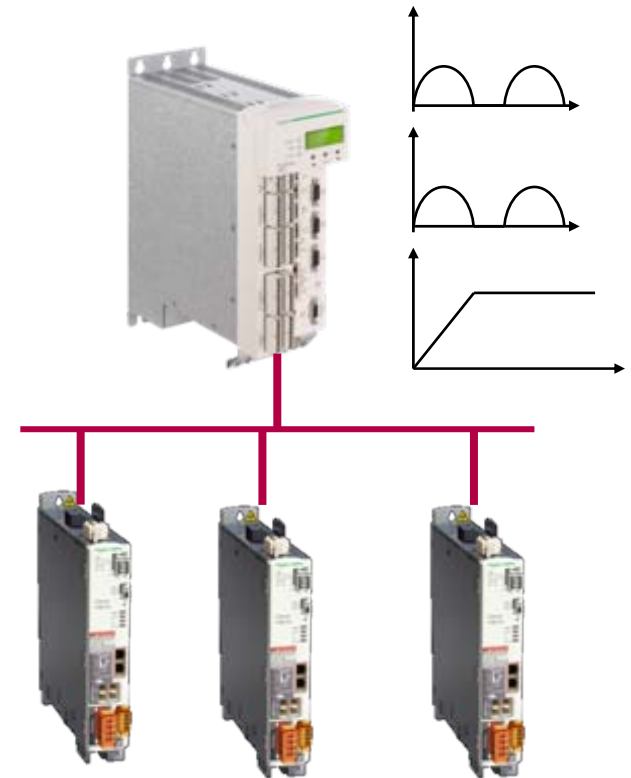
- DE 3840231 – Fujitsu machinery
- Horizontal flow packer

Shortcomings of coordinated actuators

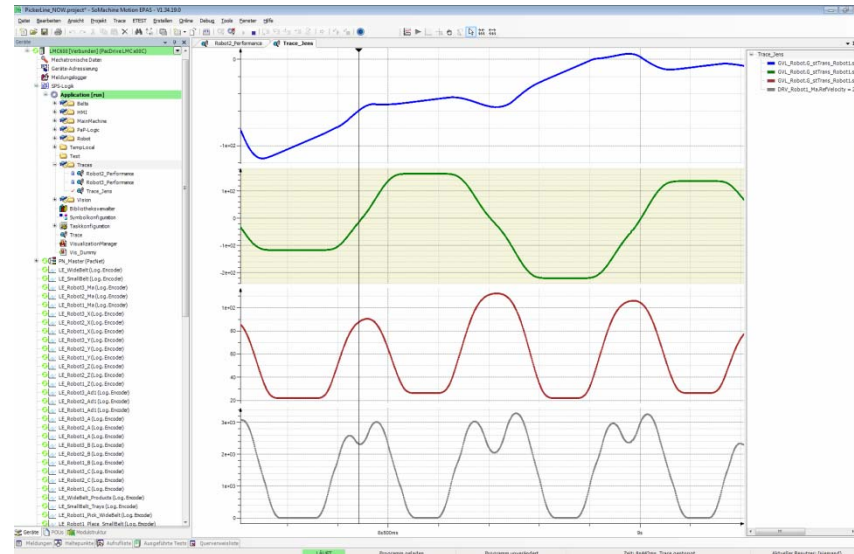
- Actual position of actuator is assumed by controller very often
- In case of exceptions machine has to be put to initial state to restart
- Difficult to adapt motions on the fly if several axes are involved (if supported by actuators)
- Limited flexibility
- Behavior and programming depends strongly on actuators

Approach 3: Synchronized motion

- Motion profiles are handled in the controller
- Drives are getting set points at a fixed interval
- All motions can refer to position of one (virtual) master axis



Properties



- Fixed position relationship between the axes
- Motion profiles can be adjusted or even modified on the fly
- Multiple axis can be adjusted fully synchronized to each other
- Data from all axes is available in the controller

Benefits

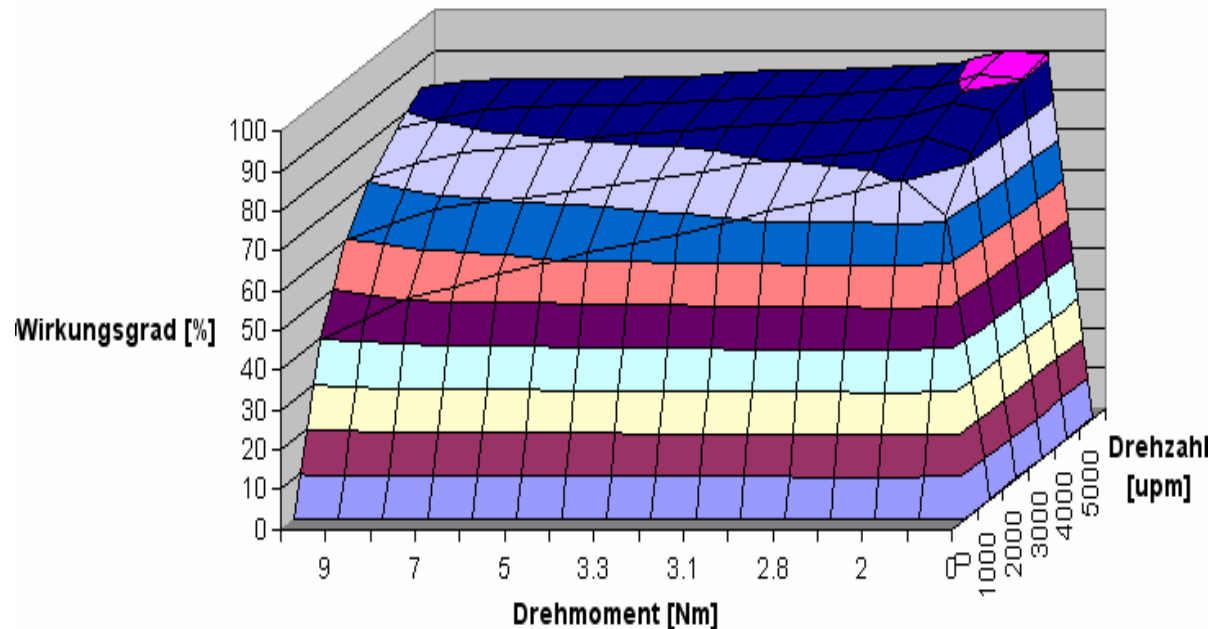
- Even in case of an exception axes stay synchronized
- Simplified recovery from exceptions
- Controller monitors and reacts to all actuators immediately
- Controller can calculate and adapt motions on the fly, e.g. robots

Performance

How synchronized servo axes enhance
performance, flexibility and efficiency

Efficiency of a synchron servo motor

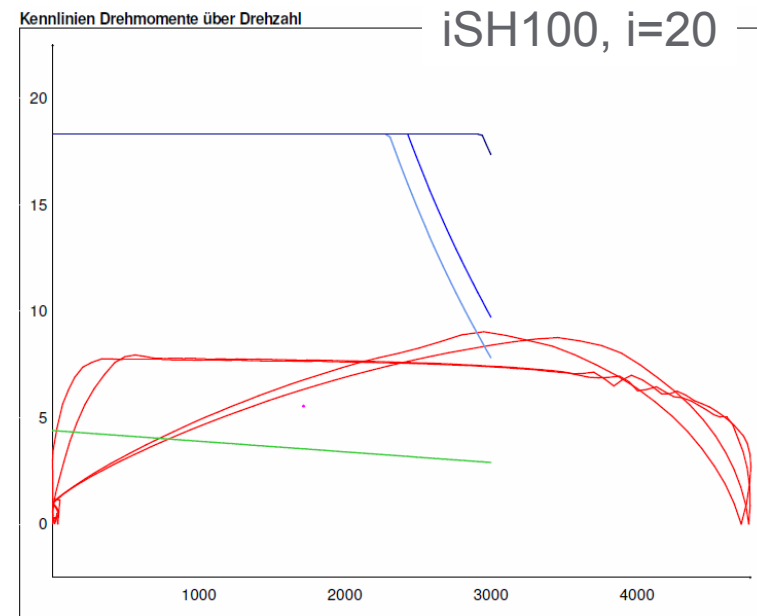
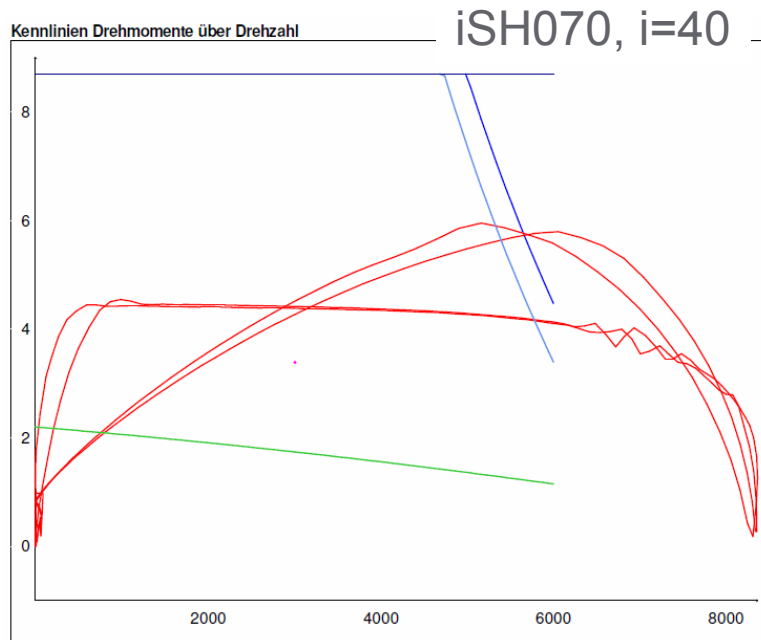
Source: Measurements done by Schneider



- Very good efficiency up to medium torque
- Very good mechanical sizing required for high dynamic applications

Increase performance

- Obvious approach: Increase machine speed
- Diagrams show identical load profile applied to two different motor / gear box combinations



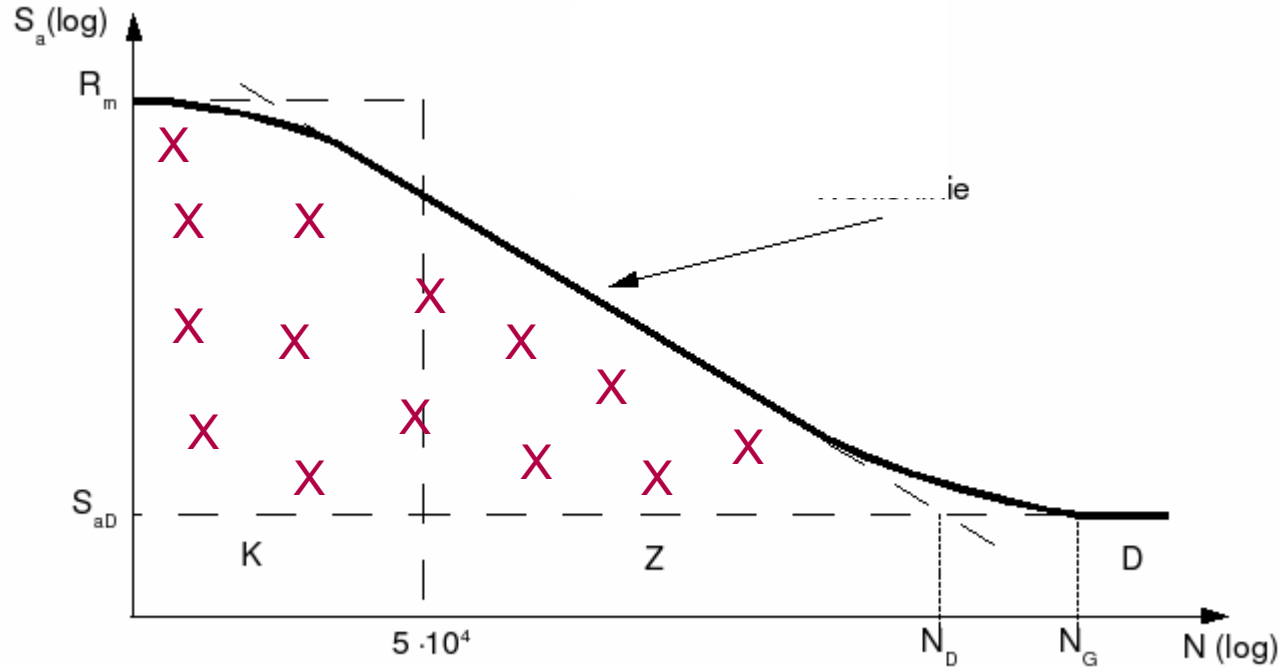
- For high dynamic applications even more powerful motor does not improve situation

Conclusion



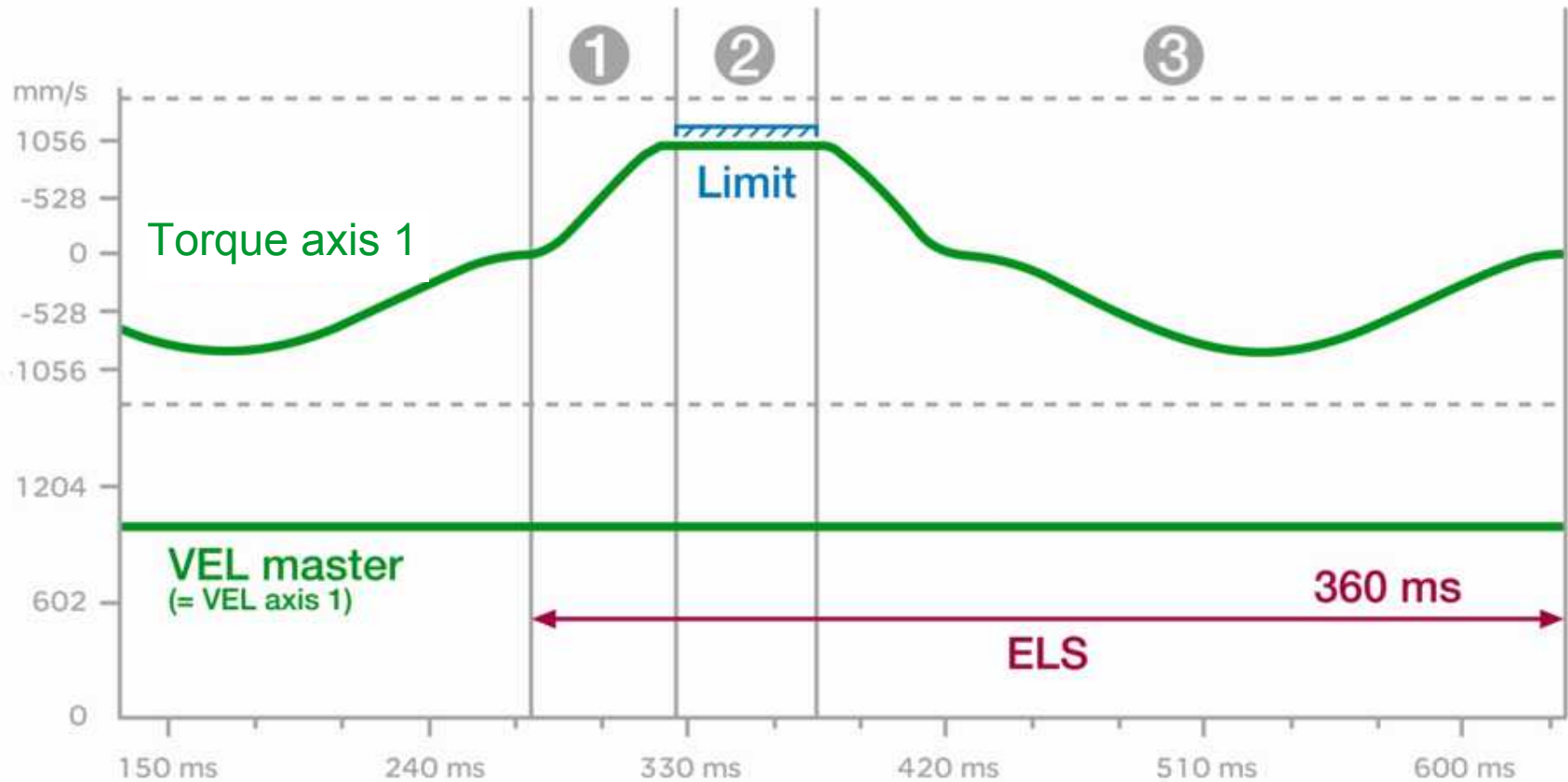
- If more powerful motor does not help → inertia of moving parts has to be reduced
- In most cases reduced inertia is similar with less material used and results in higher tension in the material

Failure due to overload

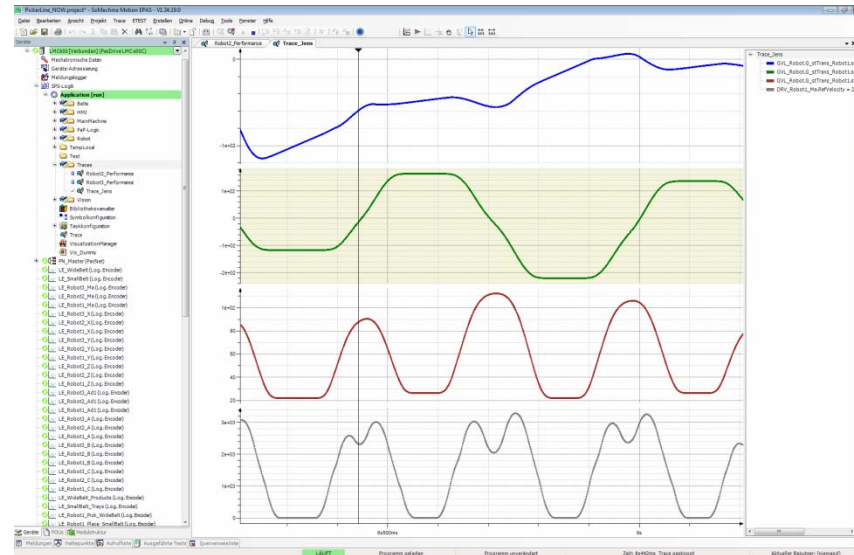
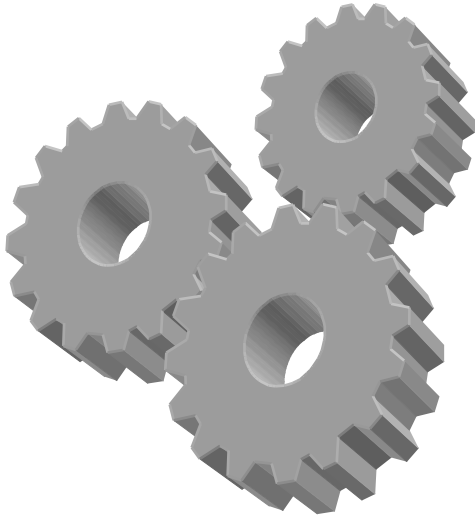


- Risk for machine failure rises with uncertainty of load profile
- Servo motors have high ratio of peak- vs. nominal torque
- In highly optimized designs servo motors can overload attached mechanics

Torque clipping for overload protection

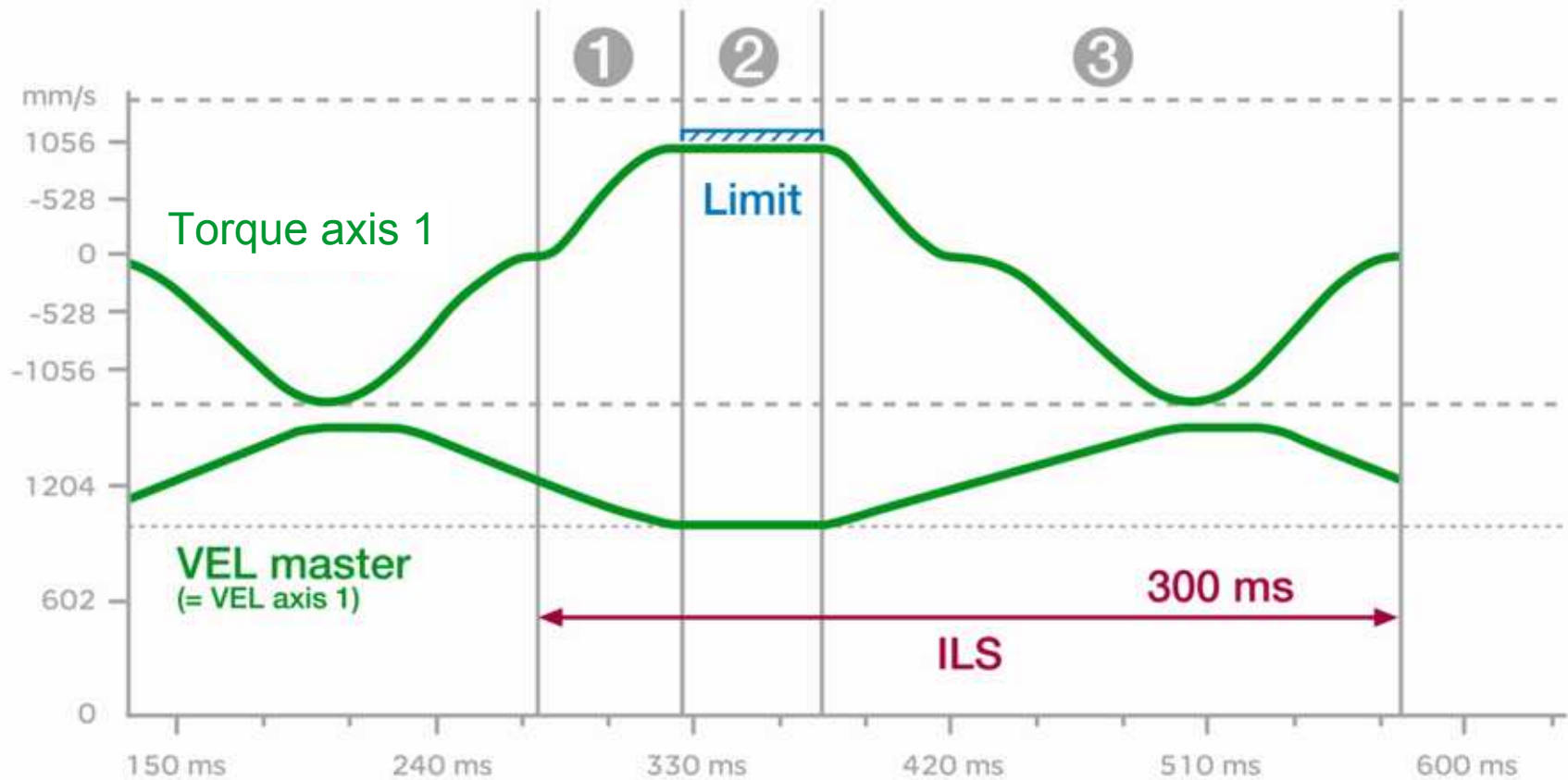


Consequences of simple clipping



- Increased following error
- If mechanical parts interfere tightly the machine crashes

Intelligent Line Shaft



- All axes are adapted automatically

Conclusion



- Synchronized motion control helps to increase **performance**
- Synchronized motion helps to increase **energy efficiency**

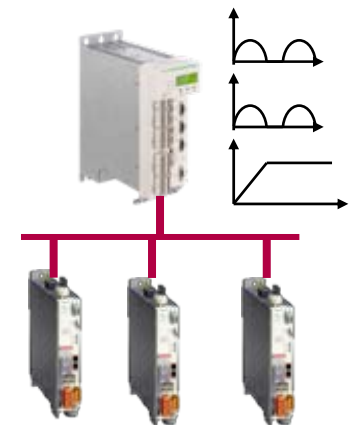
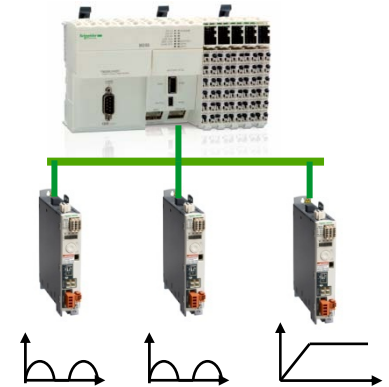
Summary

- Coordinated motion

- Adds flexibility
- Increases machine speed by electronic gearing

- In addition synchronized motion control

- Simplifies error recovery
- Increases machine speed further by running closer to mechanical limits
- Helps to save energy by eliminating peaks



NOW!
You know!