WEBINAR

24 AUGUSTI 2020

Motion – Vad styr valet av komponenter?

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Information

Stäng gärna av er mikrofon.

Ställ dessa i chattfönstret.

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https://wexoe.se/academy/

What is MOTION CONTROL?






Motion Control:

- Is the process of controlling a change in position of machinery or equipment
- Provides machine movement that is accurate (exact) and precise (repeatable)






Definition of MOTION CONTROL

in only 4 words: Spinning an electric motor - Comes in two flavours

- AC Drive System
  - VFD
  - Inverter drive
  - PowerFlex
  - AC-motor
  - Induction Motor

- Servo Drive System
  - Closed Loop Positioning
  - High Speed
  - High Precision
  - High Dynamics
  - Kinetix
  - CIP Motion
  - PM Motors

Anatomy of Motion

What are the parts of a Motion System?






- **MOTION CONTROLLER – Executes the motion program by sending motion commands to the drive**
- **SERVO DRIVE – Supplies current and voltage to the motor based on commands from the controller**
- **MOTOR – Converts voltage and current from drive into mechanical motion, either rotary or linear**
- **MECHANICAL ACTUATOR – Translates rotational motion of the motor to linear motion of the load**
- **GEARBOX – Torque increase, Speed decrease & Balance of inertia**

What parameters guides the product selection?

Single-Axis or Multi-Axis?

1-phase / 3-phase?

Surrounding environment?

Point-to-Point or Master/Slave?

DC-Bus?

Acceleration?

Speed?

230VAC or 400VAC?

Mechanics – Rigid/Compliant?

Type of application?

Non-Flex- or Flex-cables?

Horizontal or Vertical?

Brake or No Brake?

Torque?

Rotary or Linear?

STO or Advanced Safety?

Accuracy?

Delivery time?

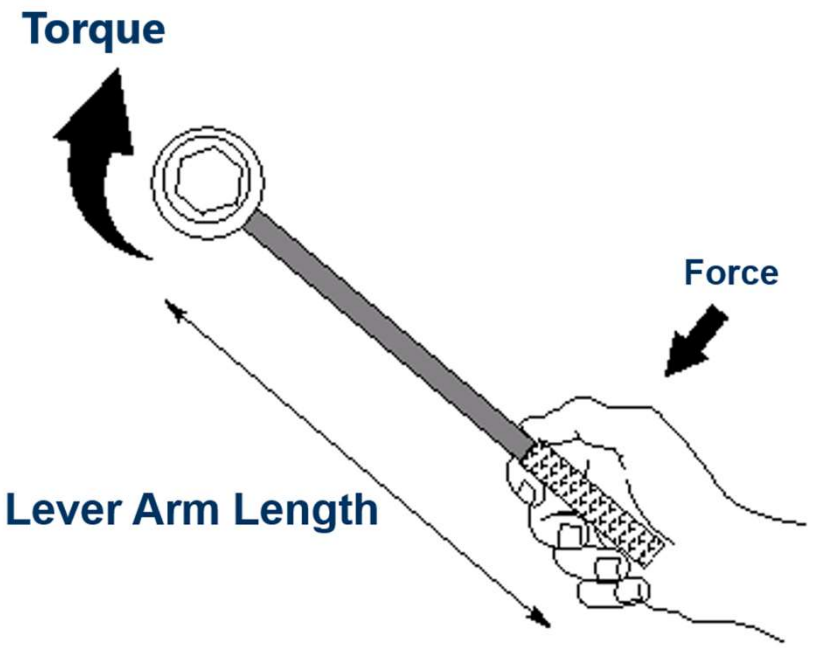
Continuous or Cyclic Application?

Dynamics?

Inertia?

Motor & Drive Selection?

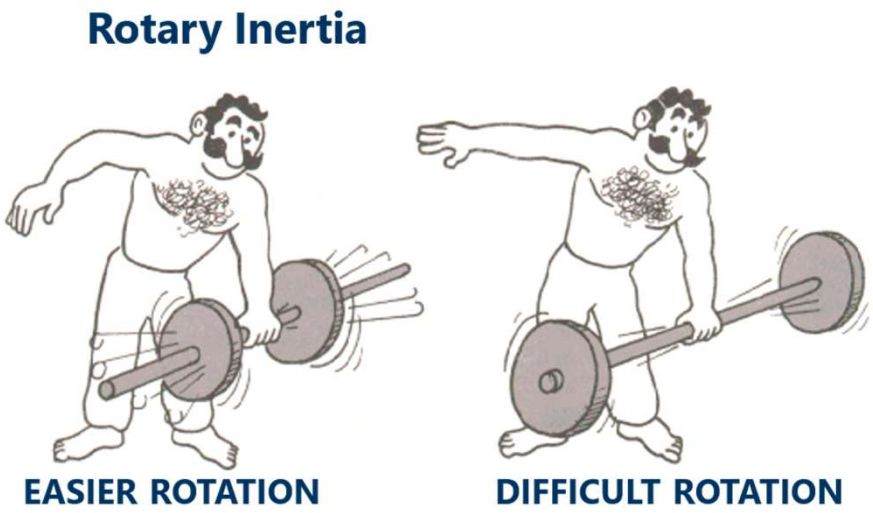
- Torque?
- Rotary Inertia?
- Speed / Acceleration / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?



TORQUE = Force * Length (of Lever Arm)

Motor & Drive Selection?

- Torque?
- Rotary Inertia?
- Speed / Acceleration / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?



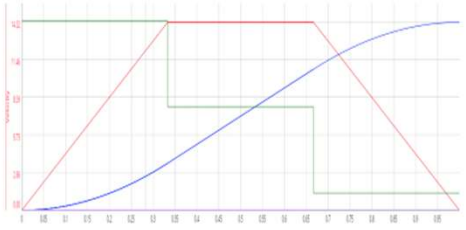
When a motor needs to accelerate a rotary load,
it is the Rotary Inertia of the load, not the weight that matters!

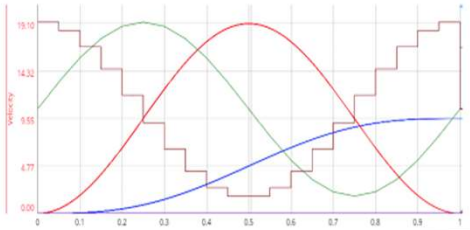
Motor & Drive Selection?

- Torque?
- Rotary Inertia?
- Acceleration / Speed / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?

Acceleration / Speed / Deceleration

- Acceleration/Deceleration = Peak Torque.
- Trapezoidal or Modified Sine?

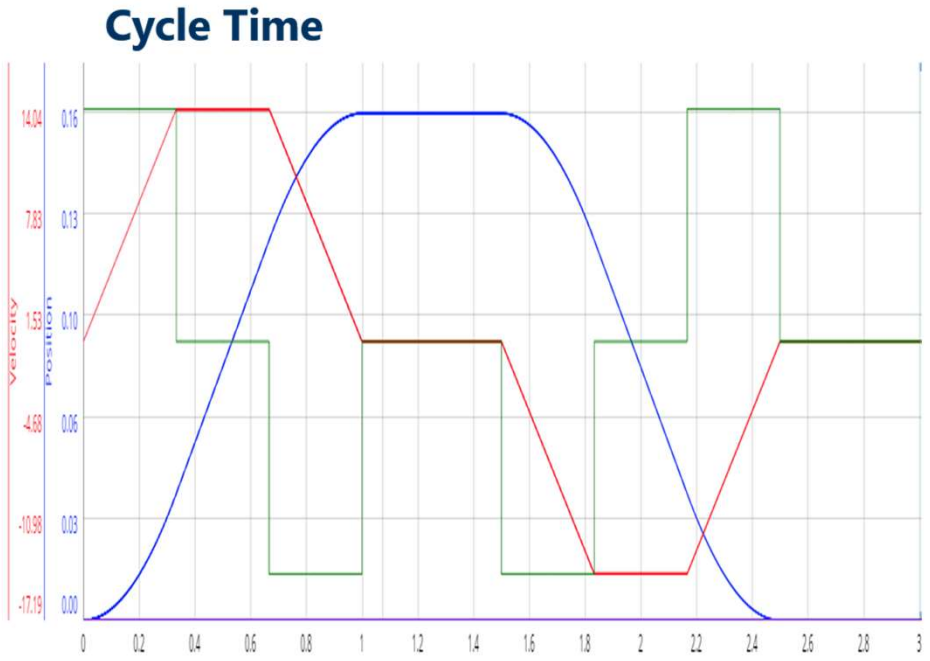




Motion Profile depends on what's needed in your application
& what kind of Mechanics used.

Motor & Drive Selection?

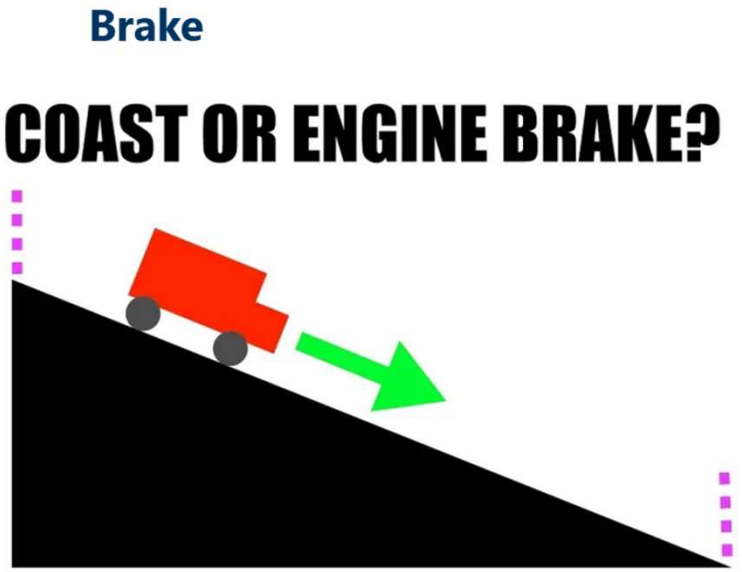
- Torque?
- Rotary Inertia?
- Speed / Acceleration / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?



Be aware of Dwell time in the calculation to avoid overheated components!

Motor & Drive Selection?

- Torque?
- Rotary Inertia?
- Speed / Acceleration / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?



Usage of Brake – Ex: Vertical load.

Motor & Drive Selection?

- Torque?
- Rotary Inertia?
- Speed / Acceleration / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?

Registration Input

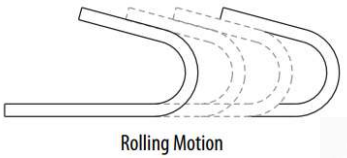
Which one would you buy?

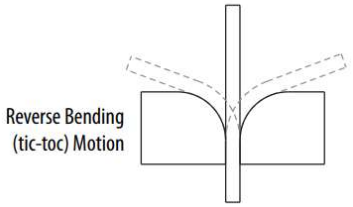
High speed "Registration" Input.
When triggered it takes a very precise "snapshot" of the current position.

Motor & Drive Selection?

- Torque?
- Rotary Inertia?
- Speed / Acceleration / Deceleration?
- Cycle Time?
- Brake?
- Registration Input?
- Non-Flex or Flex Cable?

Non-Flex or Flex Cable?





When the cable is a moving part, it's preferred to use a Flex cable.

Gearbox Selection – in-line, angular...

Gearbox Selection – in-line, angular…

What parameters guides the product selection?

Straight or right angle?

What precision is needed?

Surrounding environment?

Installation, what fits?

Does the motor fit to the gearbox?

Concentricity?

Speed?

Weight?

Type of application?

Protection class?

Loads on bearing?

Torque?

Controllability?

Efficiency?

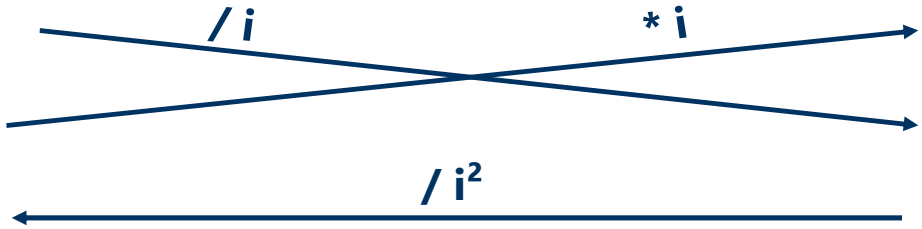
Delivery time?

Repeatability?

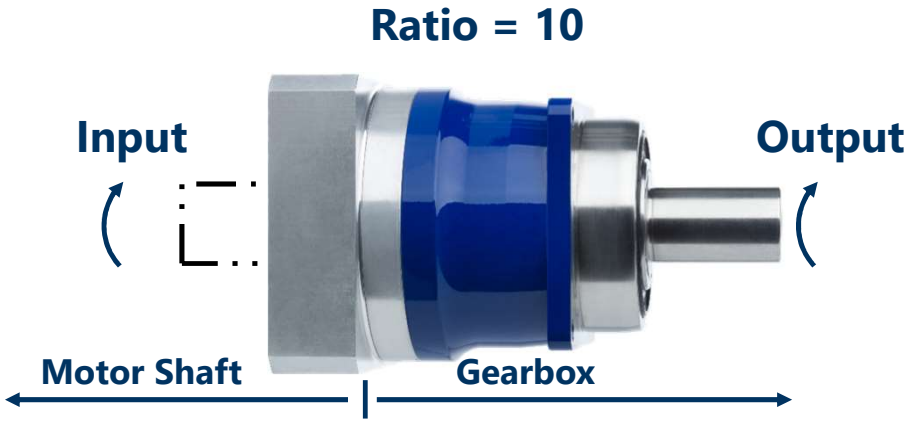
Dynamics?

Why do you use a gearbox?

- n1 = 3000 rpm
- T1 = 20 Nm
- J1= 0.10 kgm²



- T2 = 200 Nm
- n2 = 300 rpm
- J2 = 10 kgm²



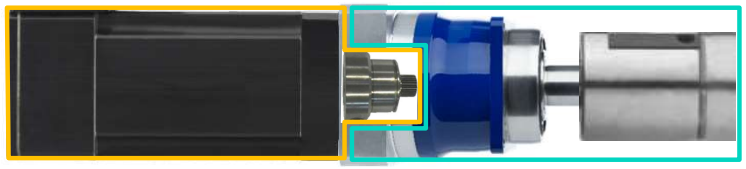
- **Speed decrease**
- **Torque increase**
- **Balance of inertia**

What does it mean – Controllability?

Definition Inertia Ratio (Lambda (λ))

Definition of Inertia Ratio (Lambda(λ)):

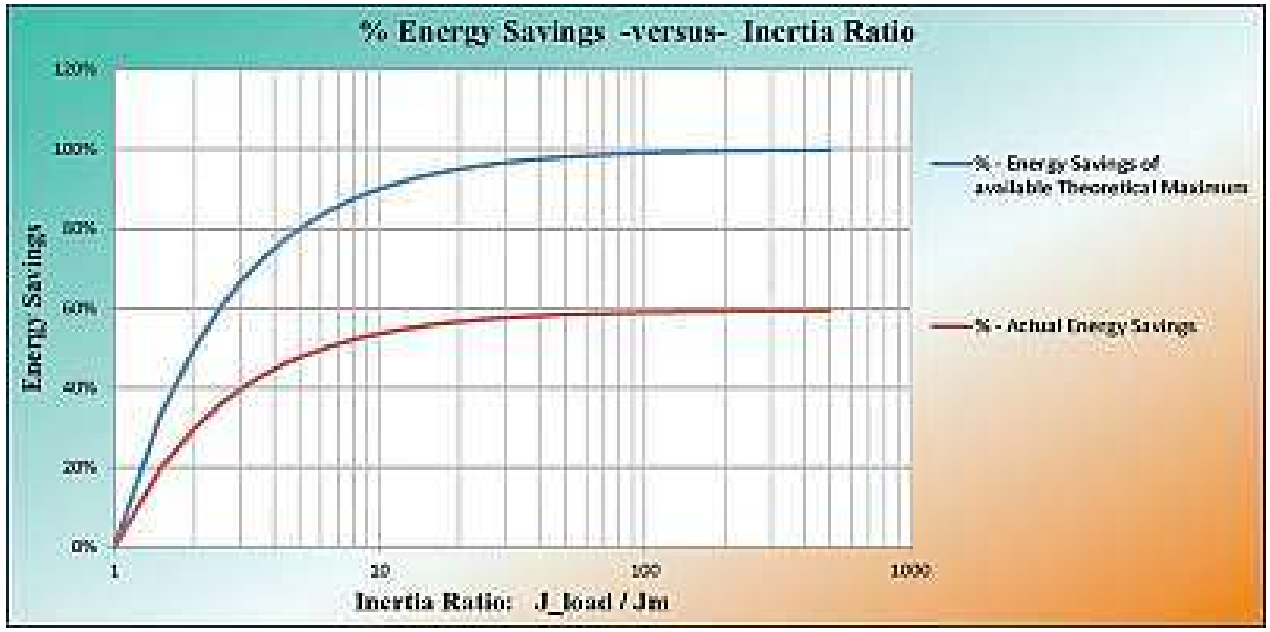
λ is the relationship between the external and the internal mass-moment-of-inertia



- $J_{internal} = J_{motor} + J_{calamping\ hub} + J_{pinion}$
- $J_{external} = J_{rest\ of\ gearbox} + J_{application}$

$$\lambda = \frac{\frac{J_{application}}{i^2}}{J_{motor} + J_{reducer}}$$

% Energy savings vs Inertia Ratio (Lambda (λ))



Always select needed Inertia Ratio to save energy

Example of Inertia Ratio (Lambda (λ))

Conditions: Jlast=700kgcm², SPG60S (Jplanet=0,49kgcm²) (Jmotor=0,97kgcm²)

Ratio		Inertia
1:1		$\lambda = \frac{\frac{700}{1^2}}{0{,}97} = 722$
5:1		$\lambda = \frac{\frac{700}{5^2}}{0{,}52 + 0{,}97} = 19$
10:1		$\lambda = \frac{\frac{700}{10^2}}{0{,}49 + 0{,}97} = 4{,}8$

Same same but different

	NP015	vs	SP060
Ratio:	5:1		5:1
Torque:	40 Nm		42 Nm
Output Shaft:	Ø16-28		Ø16-28
Length:	119 mm		137,6 mm
Diameter:	Ø70 mm		Ø68 mm
Torsional rigidity:	3,3 Nm/arcmin	**36%**	4,5 Nm/arcmin
Backlash:	<8’	**100%**	<4’
Noise:	64 dB(A)	**400%**	58 dB(A)
Radial load:	1450 N	**93%**	2800 N
IP-class:	IP64		IP65
Inertia:	0,2 / 0,5		0,15 / 0,2 / 0,52
Price:	1		2

Same same but different

NP015S-MF1-5-1A1-1S	
Total	96%
T_{2B}	83%
T_{2N}	45%
n_{1Max}	31%
n_{1N}	9%
F_{2RMax}	80%
F_{2AMax}	0%
M_{2KMax}	96%
S1	45%
S5	83%

NP015S-MF1-5-1A1-1S	
Operating mode	Cycle
f_S	2,05
T_{2bfs}	33 Nm
T_{2m}	9,44 Nm
M_{2k}	59,28 Nm
l_{fq}	15 mm
S_F	4,01
S_D	2,56
L_{h10}	52267 h
L_{h10}	> 20000 h

SP060S-MF1-5-1E1-2S	
Operating mode	Cycle
f_S	2,05
T_{2bfs}	33 Nm
T_{2m}	9,44 Nm
M_{2k}	77,95 Nm
l_{fq}	15 mm
S_F	8,14
S_D	3,46
L_{h10}	100000 h
L_{h10}	> 20000 h

SP060S-MF1-5-1E1-2S	
Total	79%
T_{2B}	79%
T_{2N}	36%
n_{1Max}	42%
n_{1N}	10%
F_{2RMax}	48%
F_{2AMax}	0%
M_{2KMax}	51%
S1	36%
S5	79%

What backlash is needed? Ex: Leverarm with radius 500 mm:

NP: 1,16 mm
SP: 0,58 mm (0,29 with reduced backlash)

Same same but different

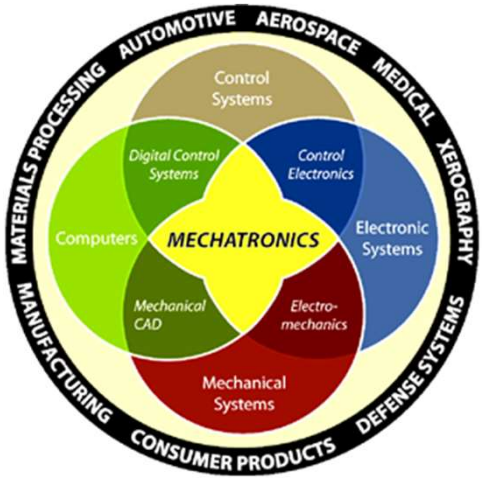
- **Application specs**
  - Torque: 100 Nm
  - Diameter: Ø500 mm
  - Circumference: 500*pi=1570,80 mm
- **CP025S-MF1-10**
  - Max Torque: 144 Nm
  - Backlash: <12 arcmin
  - Torsional rigidity: 5,5 Nm/arcmin
- **TP010S-MF1-10**
  - Max Torque: 168 Nm
  - Backlash: <3 arcmin (reduced: <1 arcmin)
  - Torsional rigidity: 23 Nm/arcmin

- CP025S-MF1-10
  - Backlash [mm]: 12*1570,8/21600 = 0,87
  - Torsional backlash [mm]: (100/5,5)*1570,8/21600 = 1,32
  - Backlash total [mm]: 0,87 + 1,32 = **2,19**

- TP010S-MF1-10
  - Backlash [mm]: 3*1570,8/21600 = 0,22
  - Torsional backlash [mm]: (100/23)*1570,8/21600 = 0,32
  - Backlash total [mm]: 0,22 + 0,32 = **0,54**

Motion Analyzer Online Tool

- DESIGN & SIZING PROCESS
  - Define Motion
  - Select & Size
  - Analyze

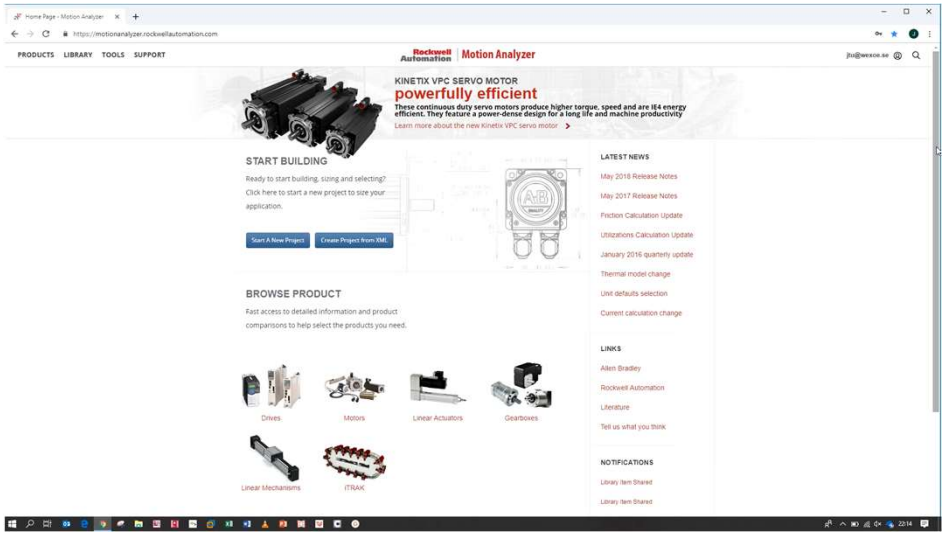


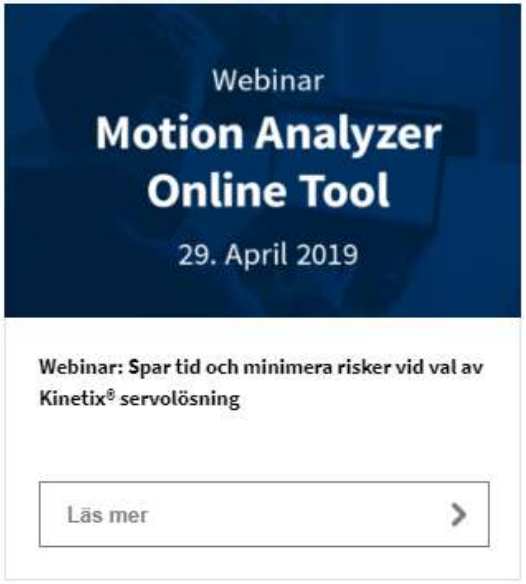
- MOTION & DRIVE PRODUCTS

Motion Analyzer is a sizing and selection tool for mechatronics systems

WEXOE Kunskapsdelning

- https://wexoe.se/aiovg_videos/webinar-motion-analyzer-online-tool/





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Tack för er uppmärksamhet

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