

Mechanical unbundler

Industrial training system for the maintenance of alignments and transmissions

The Mechanical Decoupler at a glance

> Educational Highlights & Activities

- ✓ Product based on an industrial reality (system for unbundling a stream of bottles in a production line) to make students aware of the problems of transmission maintenance (shaft alignment, pulleys, sprockets and belt tension, chain)
- ✓ Ideal product for maintenance activities in the fields of alignment and mechanical transmission
- Assembly, disassembly and adjustment of implemented transmissions
- Fault diagnosis using industrial measuring equipment
- ✓ Dynamic functional tests of mechanical operations performed by students
- ✓ Implementation of industrial instrumentation for shaft alignment, pulley alignment, sprockets, belt tension and vibration studies
- ✓ Wide variety of mechanical components
- ✓ Functional analysis and study of the construction solutions of the deconsolidator (3D Solidworks delivered with the product)
- ✓ Kinematic studies and dimensioning of the main elements
- ✓ Remote control cabinet for electrical wiring and automation activities

> Specific components

- ✓ Gear motor and drive
- ✓ Worm / star assembly
- ✓ Two pallet chain conveyors
- ✓ Five bevel gearboxes
- ✓ A belt and pulley transmission
- ✓ A sprocket-chain transmission replaceable by a pulley/V-belt assembly
- ✓ Two gimbals
- ✓ Couplings and synchronising shafts
- ✓ Power cabinet

> Features

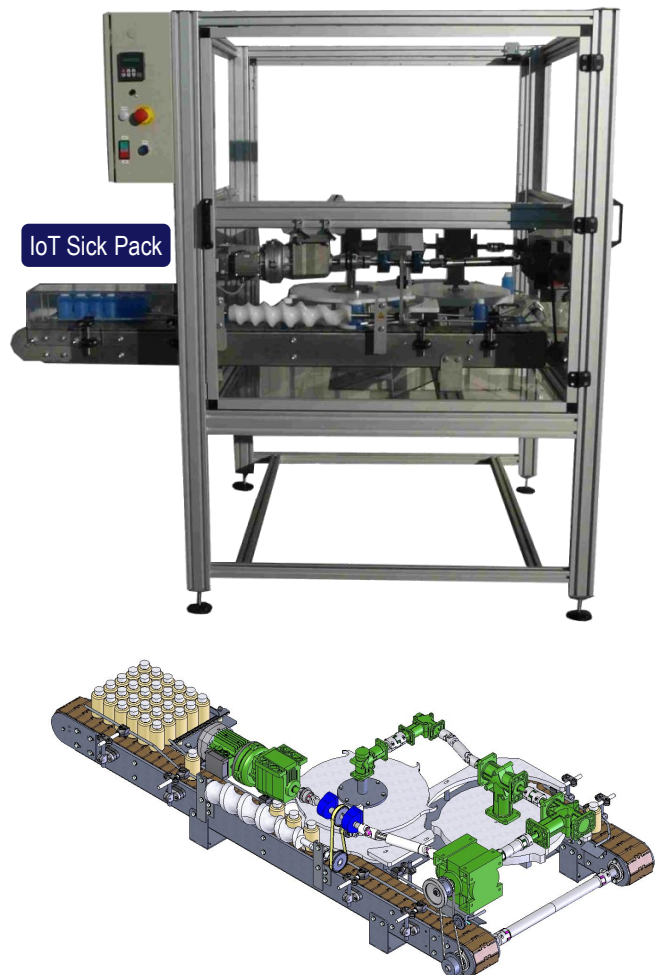
- ✓ L / W / H: 2000 x 1300 x 1900 mm - Open doors: 3100 x 3600 x 1900 mm
- ✓ L / W / H: Remote cabinet DE20: 1100 x 510 x 900 mm
- ✓ Electrical energy: DE10: 230V-50Hz per mains (protection via a 30mA instantaneous differential circuit breaker SI and TT neutral system at the customer's expense)
- ✓ DE20: 400V-50Hz (3 phases + neutral + earth) to be connected to a mains socket
- ✓ Weight: 250kg

This system is accompanied by a technical and educational file

Bac PRO MSPC

BTS MS - IUT

Universities - Engineering schools



References

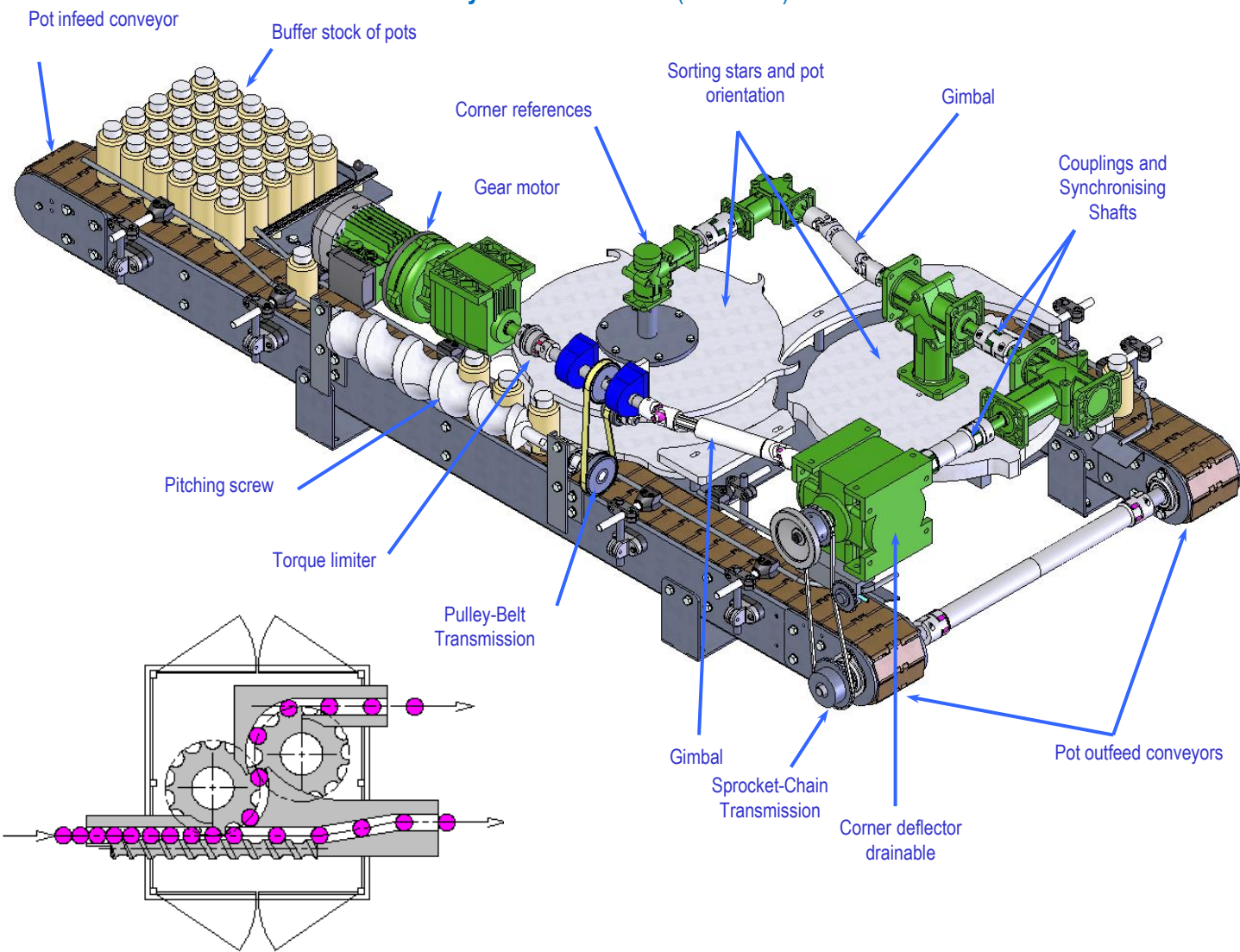
- Attention two versions of Unbundler
- ✓ DE10: Mechanical unbundler and its power box
- ✓ DE11: Remote control panel for DE10 automation
- ✓ DE20: Mechanical unbundler and its power cabinet + a control cabinet with 3 removable boards
- ✓ DE24: Option: Parts for format change Jars <=> Vials
- ✓ DE19: Option: Mechanical kit: short conveyor kit
- ✓ DE13: Drainable corner transmission case
- ✓ DE21: Case for stress-free cornering
- ✓ DE18: Specific tools
- ✓ DE14: Shaft Alignment Measuring Instrument with shim set
- ✓ DE15: Vibration analysis and fault finding instrumentation
- ✓ DE16: Instrumentation for measuring pulley/sprocket alignment and belt tension
- ✓ SK20: Sick TDCE Smart IoT Gateway Kit & Smart Sensors for Unbundling

Functional description

- ✓ The principle of the Unbundler is as follows: the accumulating pots are brought into line by a worm. A first star catches every second pot. The pot is then picked up by a second star which deposits it on another conveyor, the second pot continues its journey on the first conveyor. It is the position and number of notches in the first star that ensures that the pot is picked up or not.
- ✓ Synchronisation of the screw-wing-conveyor elements is essential, which justifies the use of a single motor for all rotations. The movement is transmitted by the angle gears, a belt, a chain, a cardan shaft and couplings.
- ✓ The advantages of corner references are :
 - to have a high return
 - to allow for a reduction in speed
 - have a low cost



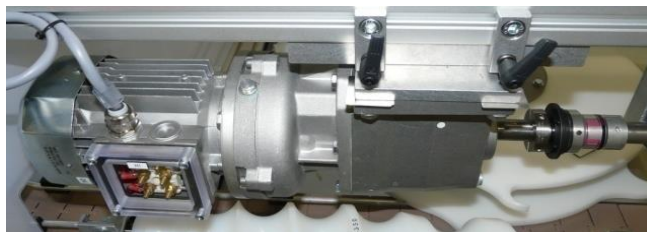
System architecture (continued)



Gear motor and torque limiter" sub-assembly

It mainly includes:

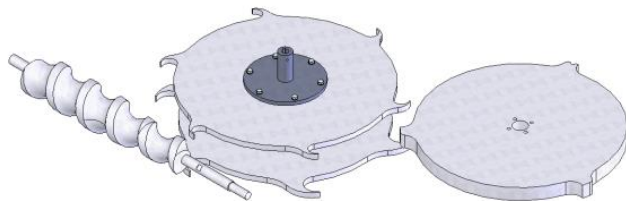
- Gear motor
- Torque limiter with integrated flexible coupling



Worm and Star sub-assembly

✓ It mainly includes:

- An auger that ensures the pitching of the pots on the infeed conveyor
- Two stars which ensure the sorting and orientation of the bottles towards one or other of the conveyors
- ✓ Students can intervene on:
 - The synchronisation of the screw and the first star
 - The synchronisation of the two stars
- ✓ These operations require the loosening of couplings in order to free the rotations of each of the elements
- ✓ This set has been designed specifically for this type of bottle.





System architecture (continued)

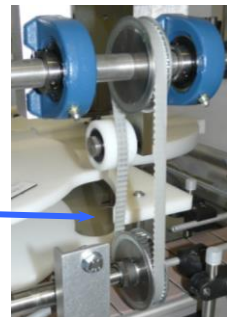
Conveyor" sub-assembly

- ✓ It mainly includes:
 - A long conveyor for the entry of the vials and the departure of the first stream of vials
 - A short conveyor positioned at the exit of the second star and ensuring the departure of the second stream of vials
 - A transmission shaft that links the movement of the two conveyors

Belt and pulley transmission" sub-assembly

- ✓ It mainly includes:
 - Two pulleys
 - A toothed belt
 - A manually adjustable belt tensioner
 - An expanding hub (Single nut locking hub, allows the assembly of pulleys or sprockets on a shaft without keys or needle screws)
 - Two cast iron short plummer blocks to support the drive pulley shaft
- ✓ This sub-assembly ensures the rotation of the worm from the motor

Tension roller belt



Gimbal" sub-assembly

- ✓ It mainly includes:
 - A tele-scopic gimbal
- ✓ It serves as a mechanical link between the motor and the first angular gearbox
- ✓ The use of a cardan shaft is imposed by the need to offset the input shaft of the angular gearbox for space reasons.

Chain tensioner sprocket



Chain Sprocket Transmission" sub-assembly

- ✓ It mainly includes:
 - Two sprockets with different numbers of teeth
 - A chain
 - A manually adjustable chain tensioner
- ✓ It ensures the transmission to the conveyors
- ✓ For student maintenance activities, it can be replaced by a V-belt pulley assembly to eliminate greasing and reduce noise.



Mechanical Evolution Kit: V-belt

- ✓ Replacing a chain with a V-belt
- A set of pulleys, tensioner, belt and mechanical adapters is supplied to replace the chain with a V-belt
- This allows a comparison of the operation of two transmission solutions and is justified by an improvement of the machine to reduce noise and eliminate greasing operations

Sub-assembly "Elastic Couplings and Synchronising Shafts

- ✓ It includes:
 - Simple elastic couplings
 - Connection between two corner connectors
 - Elastic couplings with spacer as transmission axles
 - Connection between the two conveyors,
 - Connection between two corner joints
- ✓ These couplings are backlash-free, with both hubs and the elastomer being preloaded



Bevel gearboxes" sub-assembly

- ✓ It mainly includes:
 - Five bevel gearboxes with different sizes and reduction ratios
 - 3 corner connectors 1 input / 1 output
 - 2 corner connectors 1 input / 2 outputs
- ✓ They ensure the mechanical connection of all the elements from the motor (Stars, worms, conveyors) and allow the speed of rotation to be reduced progressively
- ✓ One of the corner connectors is fully removable and adjustable (supplied with disassembly/reassembly instructions and 3D solidworks) for maintenance activities (installation, removal, assembly and disassembly).



Spare pulleys, idler and belt

Replacement of the chain sprocket transmission with a V-belt pulley



Mechanical decoupler VERSION DE10

Fixed power cabinet

- ✓ It mainly contains:
 - A power cable
 - A 24VDC power supply and its associated protections.
 - A variable speed drive and its associated protections.
 - A relay to control the start and stop of the drive.
 - A safety module for the management of door safety switches
- ✓ It is equipped with :
 - A BP works
 - A BP stop
 - An engine running light
 - A voltage presence indicator
 - A reset button
 - A disconnecting switch
 - A remote keypad for displaying and setting the drive parameters
 - A potentiometer for setting the motor speed



Wearing parts supplied

- ✓ A toothed belt
- ✓ Five bearings (3 different models present on the Unbundler)
- ✓ Seals
- ✓ Drain plugs
- ✓ A toothed belt
- ✓ From chain to pallet
- ✓ Self-tapping sockets
- ✓ Oil
- ✓ Levels
- ✓ Bearings



Option DE10

Remote control box for automation (Option DE11)

- ✓ It mainly contains a box to be fixed to the machine frame consisting of :
 - A Twido PLC with 14 digital inputs and 10 digital outputs (ladder programmed and supplied with programming software)
 - Three photoelectric sensors and three sensor holders
 - 1 inductive sensor
- This automation allows:
 - Automatically manage the switch from low to high speed when products are detected at the entrance (control of power consumption),
 - to display a product defect,
 - to count the output products and to trigger a preventive maintenance alarm when a certain number of cycles has been reached.
- ✓ It is connected to the fixed cabinet via an industrial connector.
- ✓ This box is delivered with the following elements for connection activities and mini automation projects:
 - 2 counters (display of the number of unbundled products)
 - A control panel with buttons and lights to operate the system
- ✓ Summary of digital inputs: long conveyor count, short conveyor count, emergency stop, star tower count, start push button, stop push button, reset push button, maintenance counter.
- ✓ Summary of digital outputs: low speed, high speed, maintenance indicator, bottle arrival fault indicator, counter 1 output, counter 2 output





Mechanical decoupler DE20 VERSION

Main cabinet

- ✓ It can work without the remote cabinet and contains mainly:
 - A power cable
 - A 24VDC power supply and its associated protections
 - A security module for security management
 - A direct motor start to start the system
 - A set of industrial connectors to connect to the motor, to the safety switches, to the remote cabinet.

Remote control cabinet for automation

- ✓ It is equipped with a PLC (permanently mounted in the cabinet) and a place for the installation of wiring boards. It is connected to the fixed cabinet and to the operating part by means of industrial connectors.
- ✓ It is composed of :
 - 1 Twido PLC in the left-hand side with 14 digital inputs and 10 digital outputs (ladder programmed and supplied with programming software)
 - This automation allows :
 - to automatically manage the switch from low speed to high speed when products are detected at the input, using the board containing the drive (control of electrical consumption),
 - to display a product defect, to count the output products,
 - to trigger a preventive maintenance alarm when a certain number of cycles has been reached.
 - 2 counters (display of the number of unbundled products)
 - 1 pre-wired removable board with direct outlet
 - 1 pre-wired removable board with soft starter
 - 1 pre-wired removable board with one outlet per dimmer



OPTIONS COMMON TO BOTH VERSIONS

Options Parts for format change Jars <=> Vials (DE24)

- ✓ Replacement of the 2 stars, the worm and the edges
- ✓ Disassembly and reassembly procedure provided

Options Drainable corner transmission case (DE13)

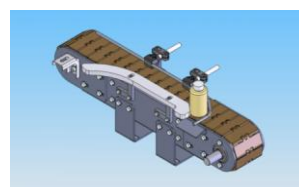
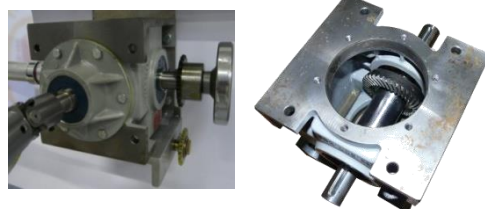
- ✓ This case contains a 1 in / 2 out angle gear similar to the one located after the cardan shaft on the drive train
- ✓ This detachable angle gear can be assembled and disassembled for maintenance activities or for the design of constructive solutions.
- ✓ This angle gear is fully modelled in Solidworks.
- ✓ Replacement seals and bearings are supplied with the angle drive.

Angle gear options without opposite (DE21)

- ✓ This sub-assembly includes a 1 in / 2 out angle gear similar to the one located after the cardan shaft on the drive train
- ✓ The axles and bearing housings have been re-machined to remove stresses and allow disassembly and assembly without special tools. It is delivered with a kit of seals and bearings.
- ✓ This detachable angle gear can be assembled and disassembled for maintenance activities or for the design of constructive solutions.
- ✓ This angle gear is fully modelled in Solidworks.

Mechanical kit options Short conveyor kit (DE19)

- ✓ Evolution 2: Assembly and installation of a conveyor. In the context of preventive maintenance operations, the replacement of the conveyor allows the machine's downtime to be reduced.
- An additional short conveyor is supplied in kit form for students to carry out the following operations:
 - Assembly of the pallet chain conveyor kit
 - Removal of the conveyor in place
 - Inserting the newly mounted conveyor with adaptation to the shaft connecting the long and short conveyor
- This element brings an additional workstation to the system.





OPTIONS COMMON TO BOTH VERSIONS (continued)

Option Specific tools (DE18)

- ✓ To remove the angle gear
 - Flange puller
 - Bearing puller
 - Dismantling tubes
- ✓ To adjust the angle gear
 - Torque meter
 - Depth gauge
 - Trusquin
 - Marble
 - Adjusting washers
 - Comparator + magnetic base
- ✓ To drain the angle gear
 - Trough
 - Dosing jug
 - Funnel
 - Oil
 - Seals



Optional Shaft Alignment Measurement Instrument with shim set (DE14)

✓ This instrumentation allows shaft alignment operations to be carried out at various locations in the system as part of preventive maintenance operations.



Option Instrumentation for measuring belt alignment and tension (DE16)

✓ This instrumentation allows the correction of pulley / sprocket alignment and belt tension faults



Alignment of pulleys and sprockets by laser beam

INSTRUMENTATION OPTION VERSION OF10

Option: Vibration Analysis Instrumentation

- ✓ This instrumentation provides an introduction to vibration analysis methods.
- ✓ For example, by inserting a defective bearing into the system, the use of vibration analysis will help to define the origin of the measured vibrations.
- ✓ The instrument comes with software for data transfer, monitoring and analysis of the data collected.
- ✓ This option is delivered with an unbalance (disc + mass) and bearing defect (notched bearing) detection kit.
- ✓ For the DE20 version, the motor gearbox must be replaced by a gearbox with a lower reduction (or replacement of the complete gear motor (Option DE32))





Sick TDCE Smart IoT Gateway & Smart Sensors Kit for Ermaflex and Unbundler (Ref: SK20)

The Sick TDCE Smart IoT Gateway & Smart Sensors Kit for Ermaflex and Unbundler (Ref: SK20) contains :



- 1 Sick Smart IoT Gateway TDC-E200EU
- 1 IO-Link Master communicating with Node-RED to create a dashboard and generate alerts
- 1 USB IO-Link Master Kit for setting up IO-Link components
- 1 IO-Link photoelectric sensor
- 2 TOR photoelectric sensors
- 2 Temperature sensors with IO-Link signal conditioners
- 1 Vibration sensor
- 1 IO-Link compressed air meter (to detect possible leaks)
- 1 MODBUS TCP electrical energy meter

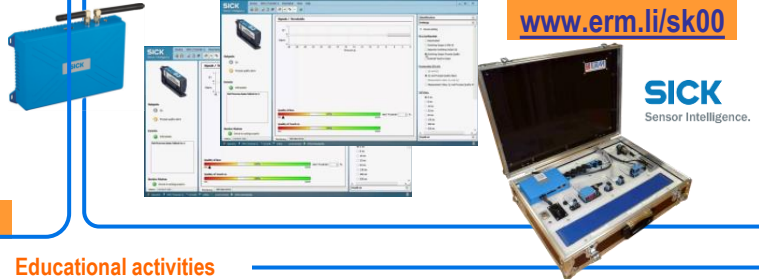
www.erm.li/sk00



Smart IoT Sick TDCE & Smart Sensors Case (SK00)

The Smart IoT Sick TDCE & Smart Sensor Gateway Toolkit contains several industrial smart sensor application cases.

www.erm.li/sk00



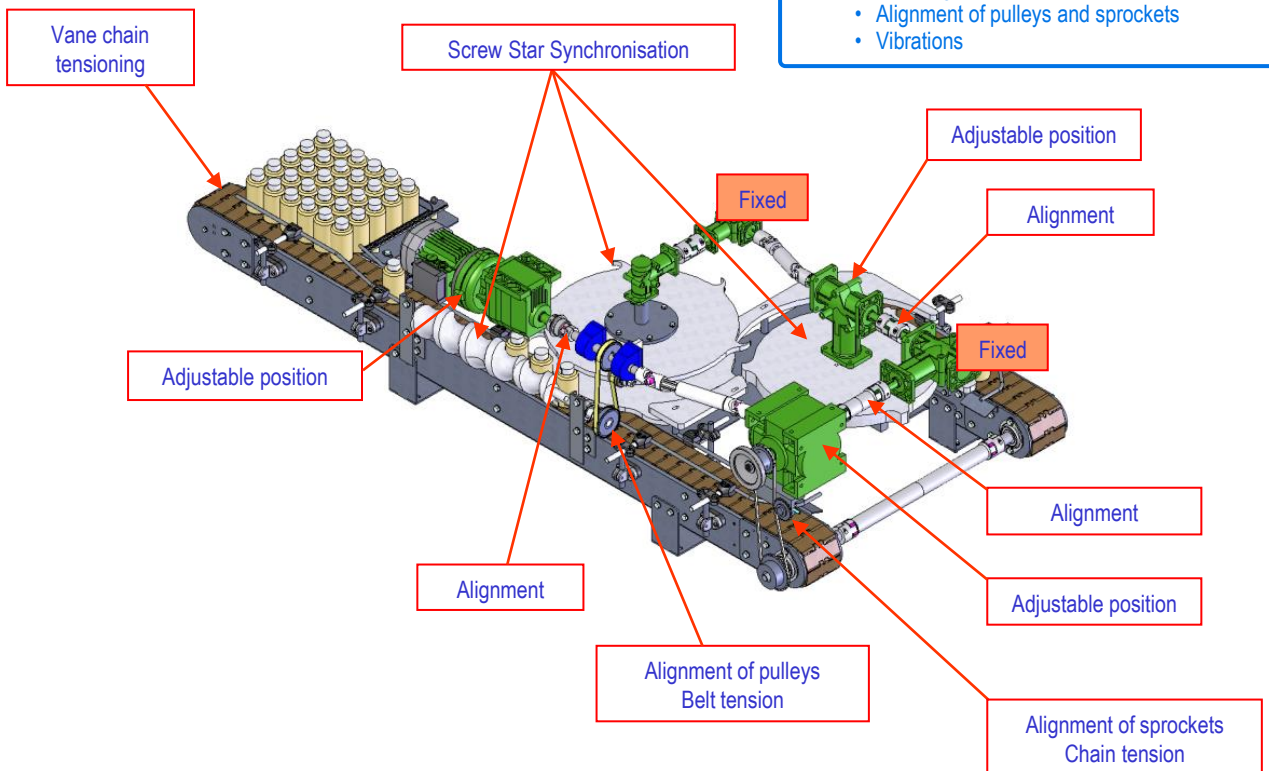
Educational activities

- ✓ Assembly, disassembly of the conveyor, couplings and drive shafts used
- ✓ Diagnosis of previously inserted faults and subsequent alignment and voltage using industrial measuring equipment
- Shifting of elements
- Loose belt and/or chain
- ✓ Observe the influence of unbalance and bearing faults on a system with vibration analysis
- ✓ Improved maintenance: change of a transmission, addition of jamming sensors at conveyor outputs (Remote cabinet), wiring of a counting kit (Remote cabinet option)
- ✓ Mounting, dismounting and adjusting an angle gear (Angle gear case)
- ✓ Drawings in Solidworks and system sizing calculations
- ✓ Electrical wiring of the remote cabinet
- ✓ Diagnosis and repair of mechanical faults (defective bearings and seals, damaged belts, etc.)
- ✓ Design of screw-wire assemblies for unbundling other types of containers
- ✓ Implementing heavy object handling procedures to facilitate operations on the angle drive

Pedagogical implementation

- ✓ Each of the transmission elements can be moved a few tenths of a millimetre to create the misalignment.
- ✓ These defects and their consequences will be observable through measuring devices such as :
 - Tree alignment
 - Alignment of pulleys and sprockets
 - Vibrations

Overview of some of the settings that can be made on the system





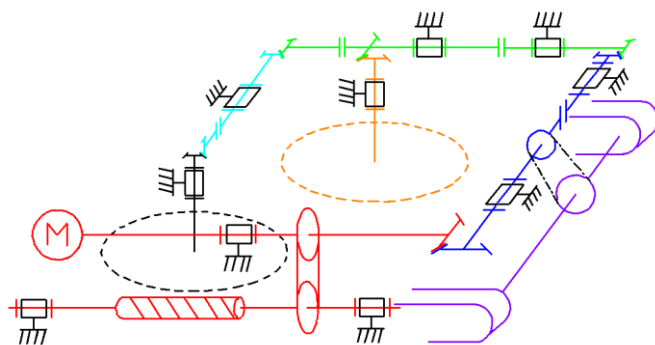
Pedagogical approach (continued)

Examples of practical work proposed by ERM for levels V and IV

- ✓ TP1: Troubleshooting (Key Breakage)
Other possible diagnostic scenarios: Belt tension, Loose couplings, Misalignment, Loose hub...
- ✓ TP2: Refurbishing the system by replacing the angle gear
- ✓ TP3: Improved maintenance, replacement of the sprocket-chain assembly with the V-belt-pulley assembly
- ✓ TP4: System maintenance inspection (Condition of bearings, tightening, synchronisation...)
- ✓ TP5: Improving maintenance, setting up an hour meter (not provided)
- ✓ TP6: Corrective maintenance of the system (Checking the control points, comparing the measurements with the reference values, validating the intervention and making the necessary adjustments)
- ✓ TP7: Functional analysis and study of constructive solutions through the replacement of a bearing

Examples of practical work proposed by ERM for levels IV and III

- ✓ TP1: Diagnosis and preventive maintenance around the desynchronisation of the system
- ✓ TP2: Monitoring and inspection, then adjustments:
 - Shaft and pulley (Alignment)
 - Belt and Chain (Tension)
 - Vibration analysis with defective bearing (In DE20 version, replacement of the gearbox (Option DE32) with a lower reduction is imperative)
- ✓ TP3: Functional analysis and study of mechanical solutions (Level III)
- ✓ TP4: Creating an inspection plan



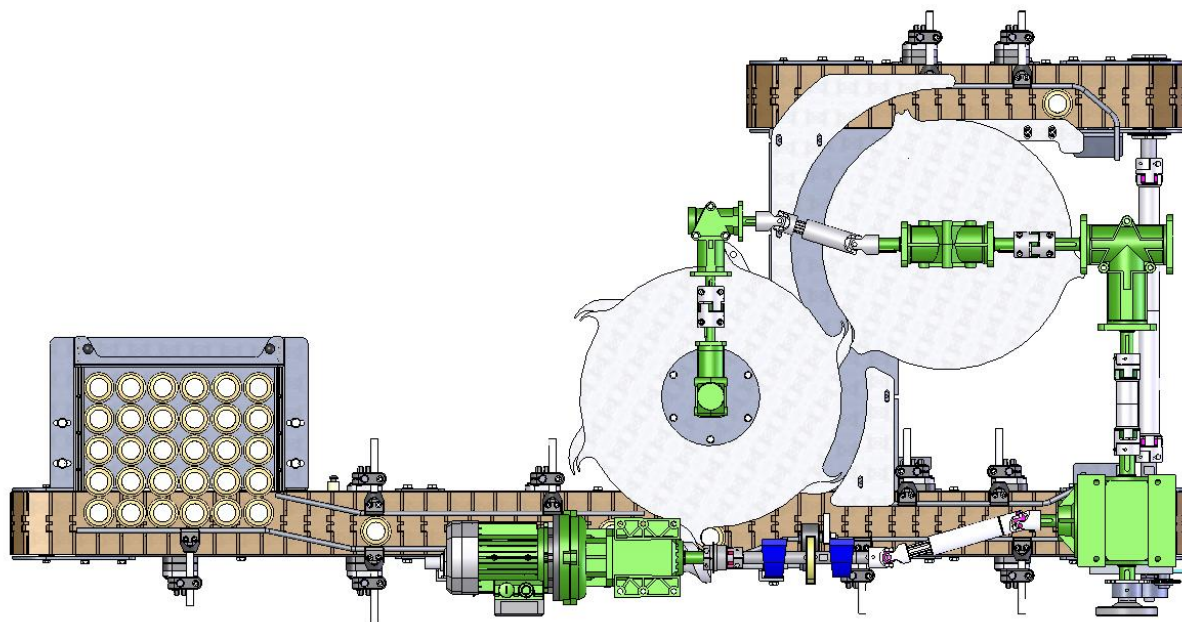
Overview of the powertrain

Examples of using the Unbundler in practical sessions

- ✓ During certain practical exercises, as the students do not immobilise the system (long power cuts, removal without reassembly of a component, etc.), other students can intervene on an element located on the other side of the system.
- ✓ This makes it possible to increase the number of workstations.
- ✓ For example, TP 2 (Level V/IV) angle gear removal and installation can be performed in parallel with TP 1 (Level V/IV) diagnosis or, more simply, in parallel with TP 6 (Level V/IV) corrective maintenance.
- ✓ Another possibility is to have a level IV student carry out a diagnostic activity and to have a level V student carry out the replacement of the defective component (Example: Belt with missing teeth)
- ✓ Construction activities thanks to the stress-free angle gear (DE21)



Mechanical intervention scenarios on the Unbundler



Mechanical repair operations (curative maintenance)

➤ Intervention on the angle gear ~ 2 to 3 hours

- ✓ Industrial scenario: Replacement of a worn or broken part (e.g. Seals, Bearings)
- ✓ Timeline of intervention:
Disassembly of the angle gear (With the specific flange removal tool supplied)
Changing a defective part (bearings, paper seal)
Adjustment of tapered roller bearing and bevel gear torques ((Option DE18 Instruments (torque meter, dial gauge, jig gauge, depth gauge) and shims supplied)).
Reassembling the angle gear
- ✓ Wear and tear: Possible wear of the paper seal and deterioration of the lip rings
- ✓ Tools required: Flat spanners, Bearing puller (optional), Flange puller (supplied)
- ✓ Spare parts/wear provided: Bearings, paper seals (Possibility to wear them out to make the repair activity more credible)
- ✓ Note: This activity can be carried out with the Angle Transfer Kit (DE13)

➤ Replacement of a short conveyor bearing ~ 2 to 3 hours

- ✓ Industrial scenario: Replacement of a worn or broken part (Bearing)
- ✓ Timeline of intervention:
Removal of defective bearing
Installation of the new landing
Alignment of the shaft between the two conveyors (Optional depending on the purpose of the activity)
- ✓ Wear generated: Low (Bearing tightened to shaft by screw)
- ✓ Tools required: Flat spanners, Allen keys, Spirit level and alignment ruler
- ✓ Spare parts/wear supplied: Conveyor bearing (Bearing cost: 5€)

➤ Diagnosis and repair of a key ~ 4h

- ✓ Industrial scenario: Diagnosis of a malfunction in the functional chain of action (key breakage)
- ✓ Timeline of intervention:
Search for the cause of the malfunction
Removal of star drive assembly 1
Dismantling the transmission assembly and replacing the key
Installation of the transmission assembly
System synchronisation and commissioning
- ✓ Wear generated: Low (Tightening of the star hub on the axle by screw)
- ✓ Tools required: Flat spanners, Allen spanners
- ✓ Spare parts/wear: Key (not supplied) (Key cost: 5€)

➤ Replacement of the defective timing belt (damaged teeth or wear) ~2h

- ✓ Chronology of the intervention:
Removal of driven pulley, torque limiter and first bearing
Removing the defective belt
Fitting the new belt
Reassembly of the bearing, governor and driven pulley
Alignment of pulleys (With dedicated tools or using a ruler)
Belt tensioning (Use of dedicated tools recommended)
Synchronisation of the screw and the stars
- ✓ Wear and tear: Tightening of the needle screw on the key
- ✓ Tools required: Flat spanners, Allen keys, Pulley/sprocket alignment device (Optional), Belt tensioning device (Recommended)
- ✓ Spare parts/wear supplied: Belt to be worn (Belt cost: 10€)
- ✓ Note: This scenario may be preceded by a troubleshooting activity

Mechanical intervention scenarios on the Unbundler

Inspection operations and preventive maintenance

> Tree alignment ~2h

- ✓ Industrial scenario: Tree alignment failure
- ✓ Possible locations of intervention:
Between the motor and the bearing
Between the first and the second angle gear
Between the 2nd and 3rd
Between the two conveyors
- ✓ Wear and tear: None
- ✓ Tools required: Allen keys, Flat keys, Shaft alignment device (Laser or Comparator)

> Replacement of bearings around the belt ~ 3 to 4 hours

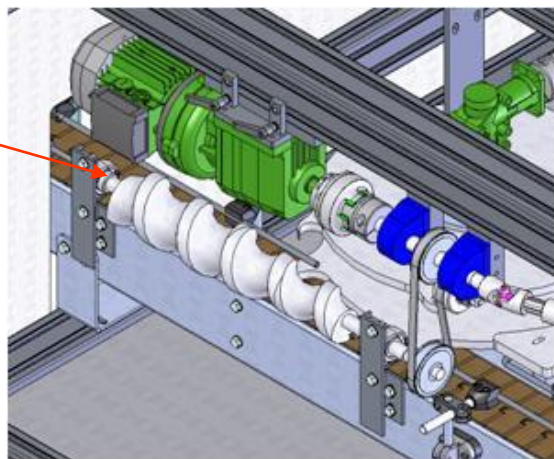
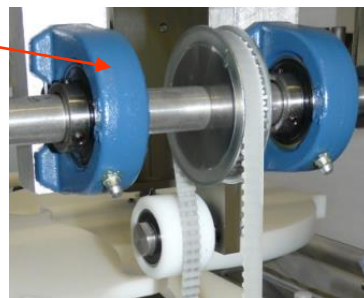
- ✓ Industrial scenario: Change of end-of-life components (bearings) after wear is detected during a preliminary inspection
- ✓ Timeline of intervention:
Disengagement of the torque limiter and cardan shaft
Removal of bearings and shaft
Changing the bearings
Installation of new bearings and shaft
Alignment of pulleys (With dedicated tools or using a ruler)
Tree alignment
Belt tensioning (Use of dedicated tools recommended)
Synchronisation of the screw and the stars
- ✓ Wear generated: Low (Tightening of bearings and cardan shaft by means of screws)
- ✓ Tools required: Flat spanners, Allen keys, Pulley/sprocket alignment device (Optional), Belt tensioning device (Recommended), Shaft alignment apparatus
- ✓ Spare parts/wear supplied: Two bearings (cost bearings 12€)
- ✓ Note: This scenario is also a good opportunity to use the skill "Analysis of mechanical solutions".

> General inspection ~ 2 to 3 hours

- ✓ Industry scenario: System inspection to generate work orders
- ✓ Timeline of intervention:
Verification of lubrication and comparison with baseline data
Verification of fixings and comparison with baseline data
Checking the voltages and alignments of the transmission elements and comparing them to the basic data
Verification of couplings and comparison with baseline data
Possible adjustments or generation of work orders to the relevant maintenance department
- ✓ Wear and tear: None

> Replacement of bearings around the screw ~ 2h

- ✓ Industrial scenario: Change of element at end of life (Bearings)
- ✓ Timeline of intervention:
Removal of driven pulley, bearings and timing screw
Changing the bearings
Installation of new bearings and screw
Alignment of pulleys (With dedicated tooling or use of a ruler)
Belt tension (Recommended use of dedicated tooling)
Synchronisation of the screw and the stars
- ✓ Wear generated: Low (Tightening of the bearings on the shaft by screw)
- ✓ Tools required: Flat spanners, Allen spanners, Pulley / sprocket alignment device (Optional) belt tension (Recommended)
- ✓ Spare parts/wear supplied: Two bearings (Cost 2 bearings: 12€)



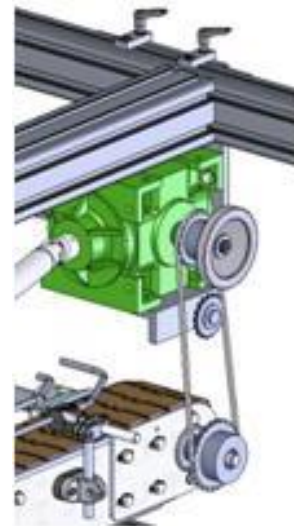


Mechanical intervention scenarios on the Unbundler

Inspection operations and preventive maintenance (continued)

> Replacement of the largest angle gear ~ 4h

- ✓ Industrial scenario: Change of element at end of life (Cornering)
- ✓ Timeline of intervention:
 - Removal of flywheel, chain and sprocket
 - Uncoupling of the cardan shaft and the drive shaft
 - Removal of the angle gear
 - Fitting the new angle gear
 - Re-coupling of the cardan shaft and the transmission axis
 - Reassembling the sprocket and chain
 - Shaft alignment (With dedicated tooling)
 - Alignment of sprockets (With dedicated tools or using a ruler)
 - Chain tension
 - Reassembling the steering wheel
 - Synchronisation of the screw and the stars
- ✓ Wear and tear: None (Use of trantorque hubs)
- ✓ Tools required: Flat spanners, Allen spanners, Pulley/pinion alignment device (Optional), Shaft alignment device (Laser)
- ✓ Note: This activity can be carried out using the Cornering Toolkit (DE13)



> Replacement of short conveyor ~ 4h + 2h if short conveyor is assembled beforehand (Option DE19)

- ✓ Industrial scenario: Replacement to reduce machine downtime during a scheduled operation on the conveyor (e.g. replacement of both bearings and the drive pulley)
- ✓ Timeline of intervention:
 - Assembling the new conveyor (Note: The TP can start with an assembled conveyor)
 - Uncoupling of the drive shaft and the sole
 - Conveyor removal
 - Installation of the new conveyor
 - Re-coupling of the axle and sole
 - Tree alignment
- ✓ Wear and tear: None
- ✓ Tools needed: Flat spanners, Allen keys, Level and straightedge
- Note: This activity uses the Unbundling Mechanical Evolution Kit (DE19)

