Olympiades FANUC Ingénieur
Équipe CentraleSupelec

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Summary:

1 – Problem description;
2 – Solution description;
3 – Results;
4 – Conclusion.

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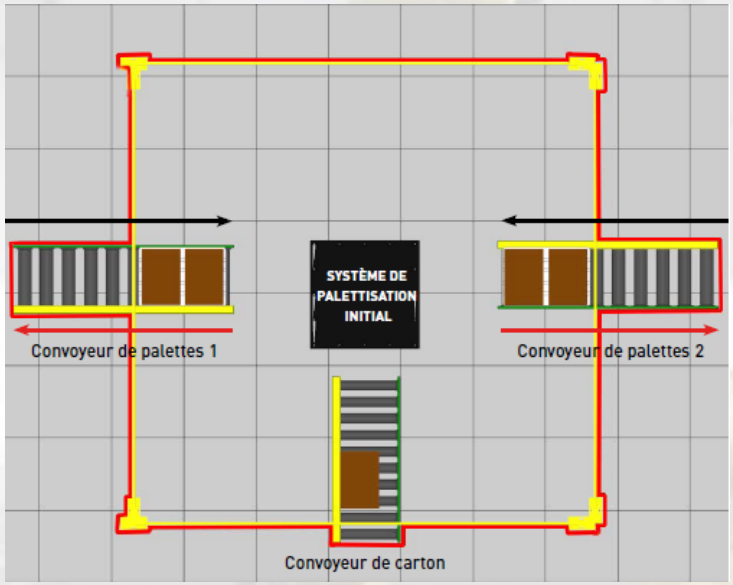
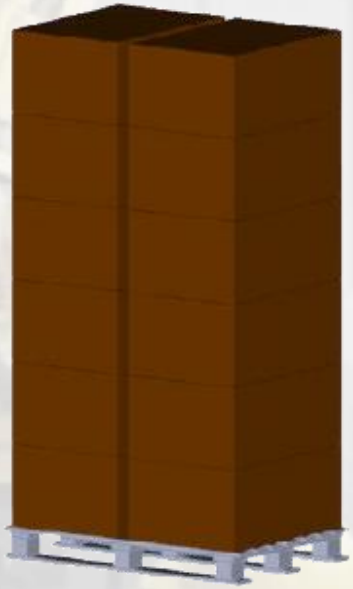
1 – Problem description

Project objective:

- Optimize the present distribution of a palletizing system of a factory



Original Surface



Pallet and boxes

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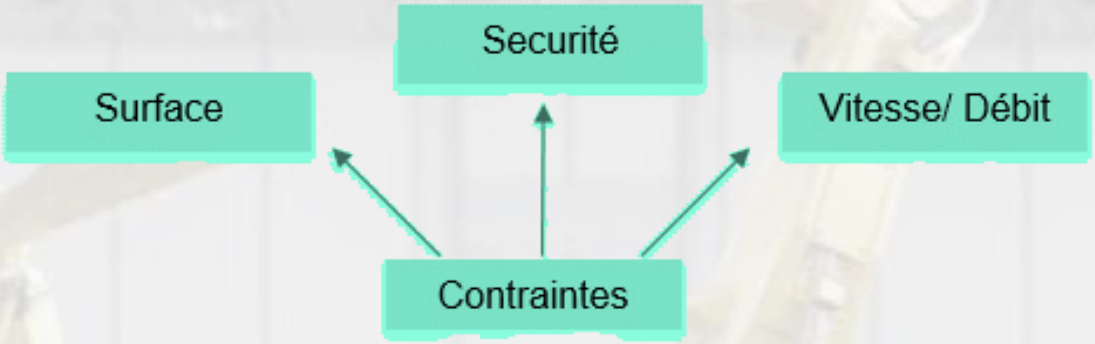
1 – Problem description

Main constraints to be followed:



- Reduce by 2 the original surface (3.6 x 3.6 m)
- Data provided: dimension of the fixtures, velocity, flow
- Safety: DCS

2 – Solution description

2.1 – Robot choice;
2.2 – Robot and fixtures positioning;
2.3 – Robot trajectory and programming;
2.4 – Robotic cell inputs and outputs;
2.5 – Operational safety considerations.

2.1 – Robot choice

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We need to analyze the problem specifications

2.1 – Robot choice

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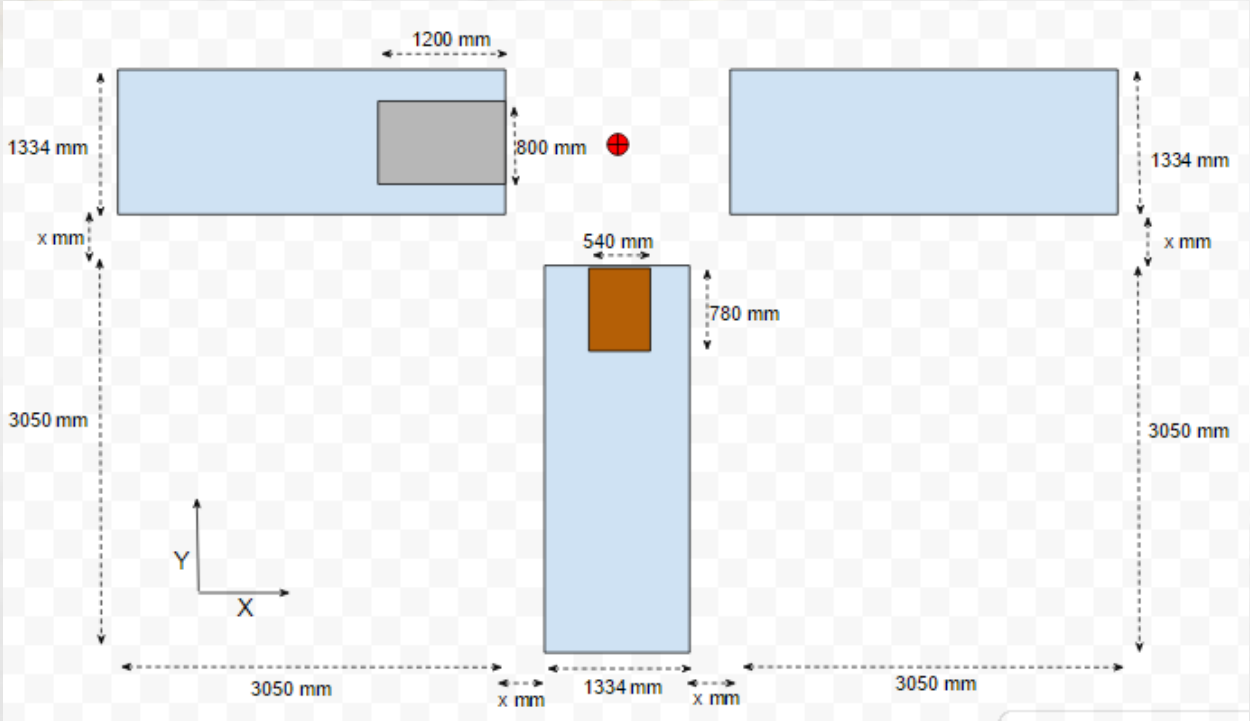
- Robot application => Palletizing;
- Payload => Gripper + Box (70 kg)
- Range of action

1812.19 mm



2.1 – Robot choice

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- Production throughput => 411 products per hour;
  one box each 8.76 seconds;

The chosen one…

R-1000iA/80H

Number of axis	5
Reach	2230 mm
Load capacity	80 kg

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2 – Solution description

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2.2 – Robot and fixtures positioning

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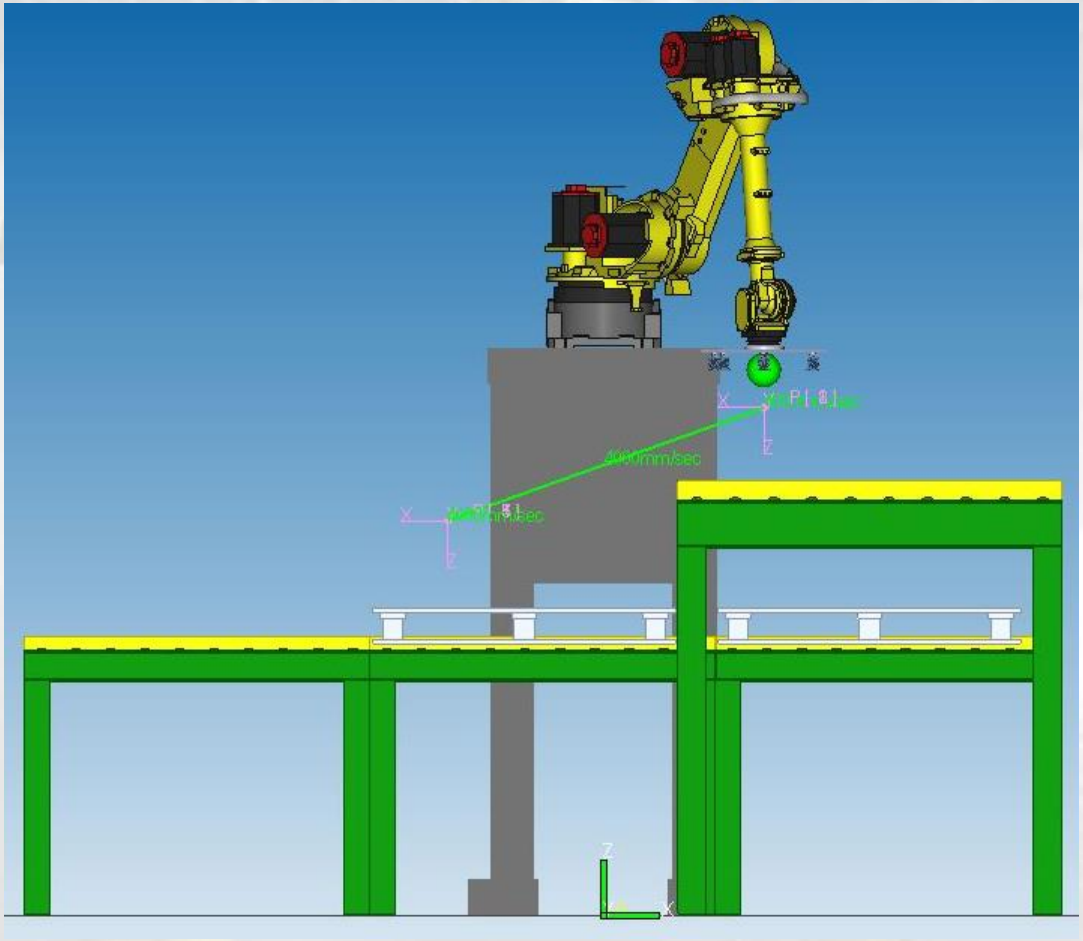
Problematic: size of the conveyors.

Solution:

verticalization!



2.2 – Robot and fixtures positioning

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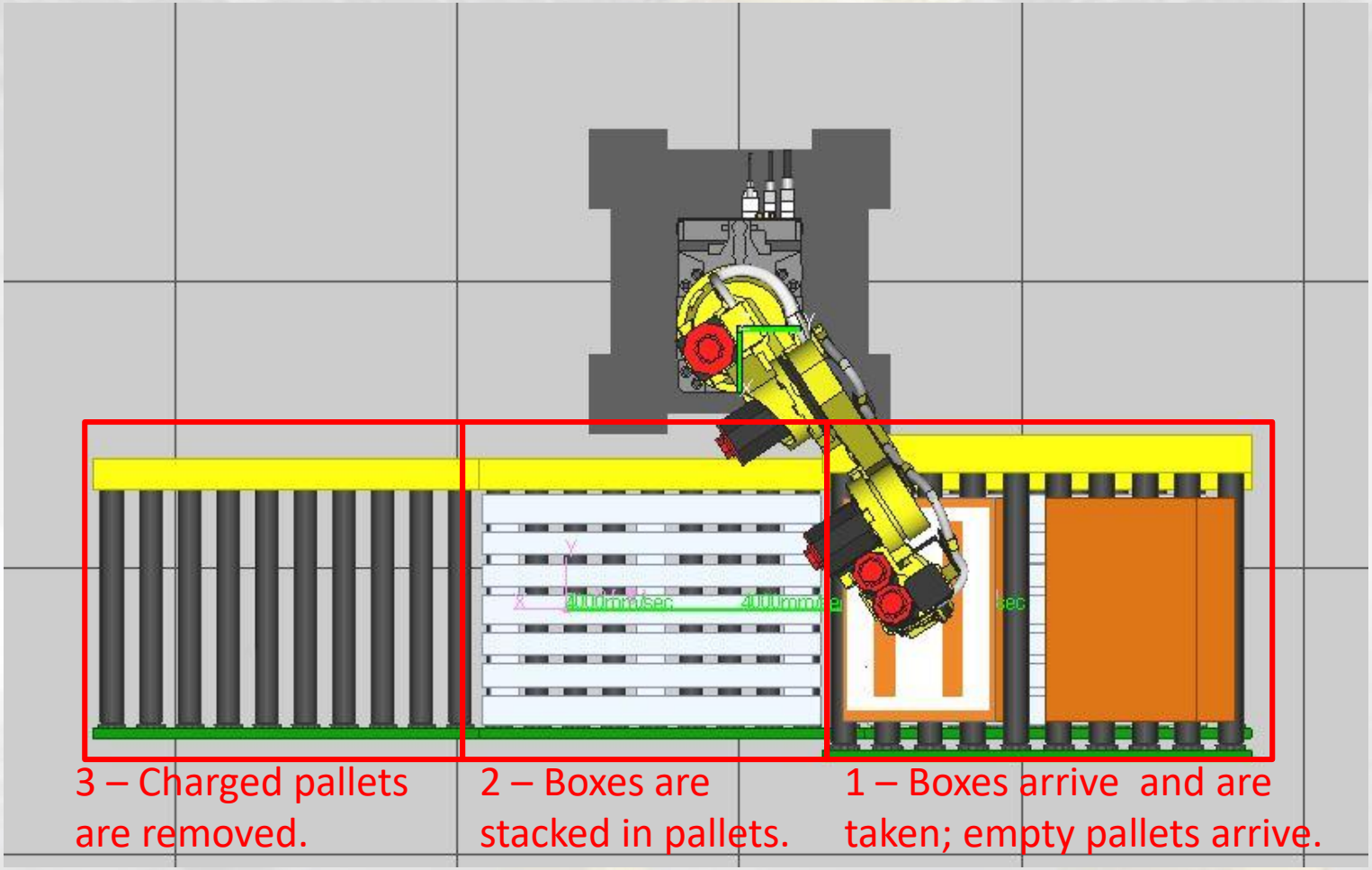

2.2 – Robot and fixtures positioning

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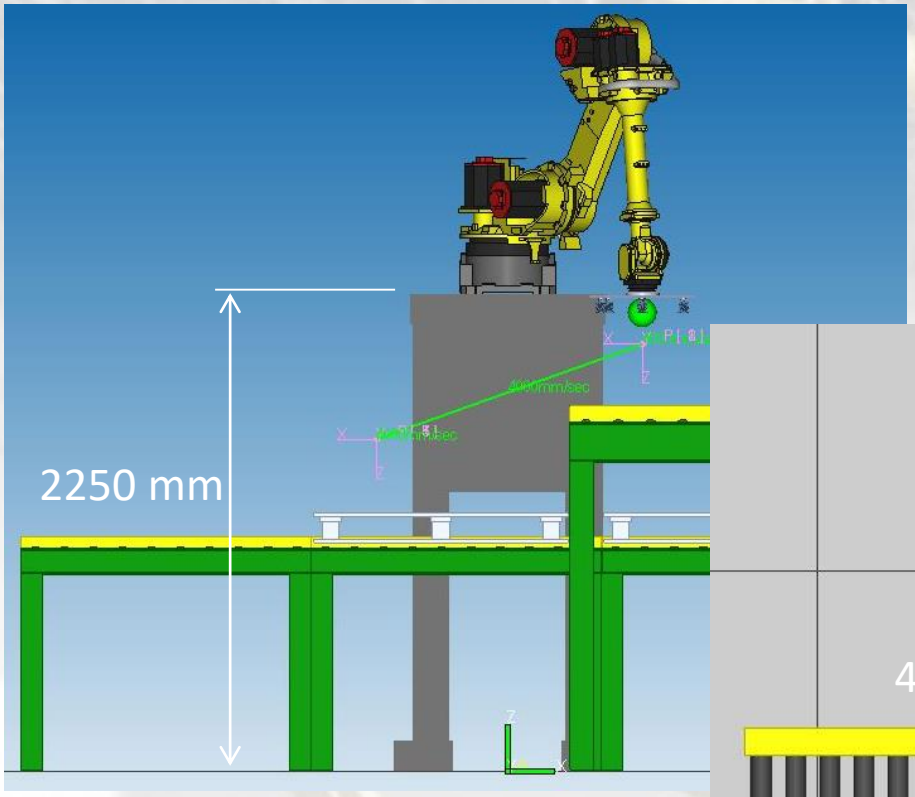

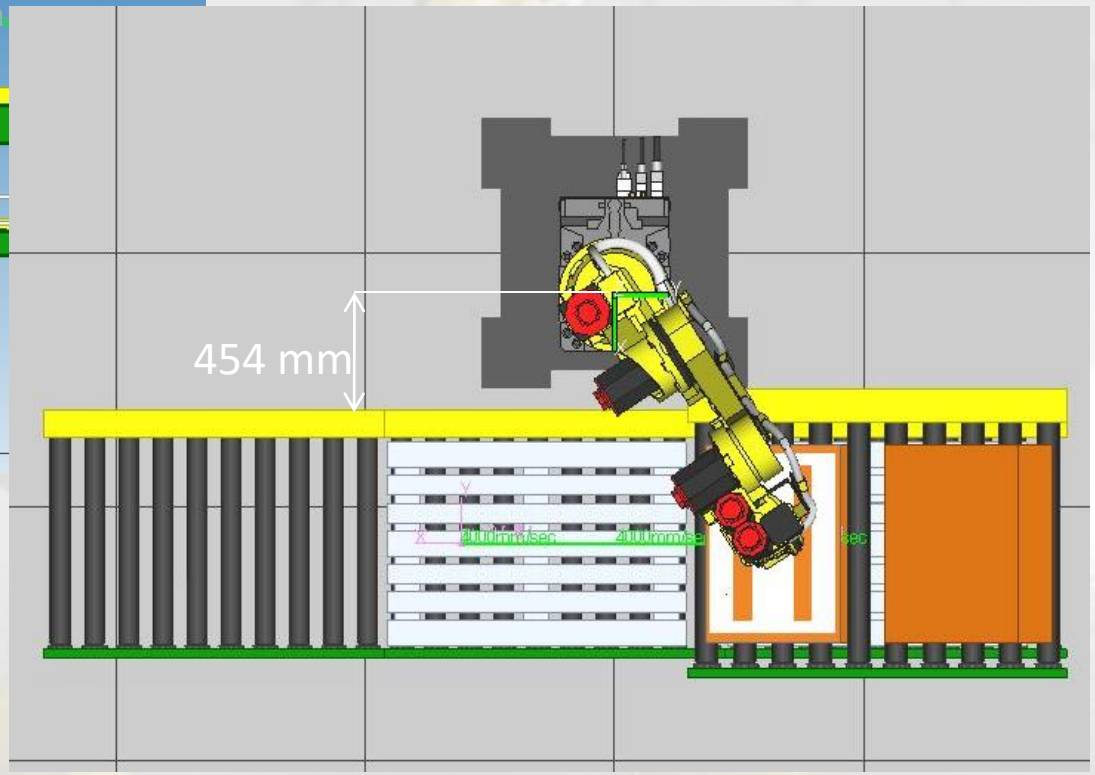

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2 – Solution description

2.1 – Robot choice;
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2.3 – Robot trajectory and programming

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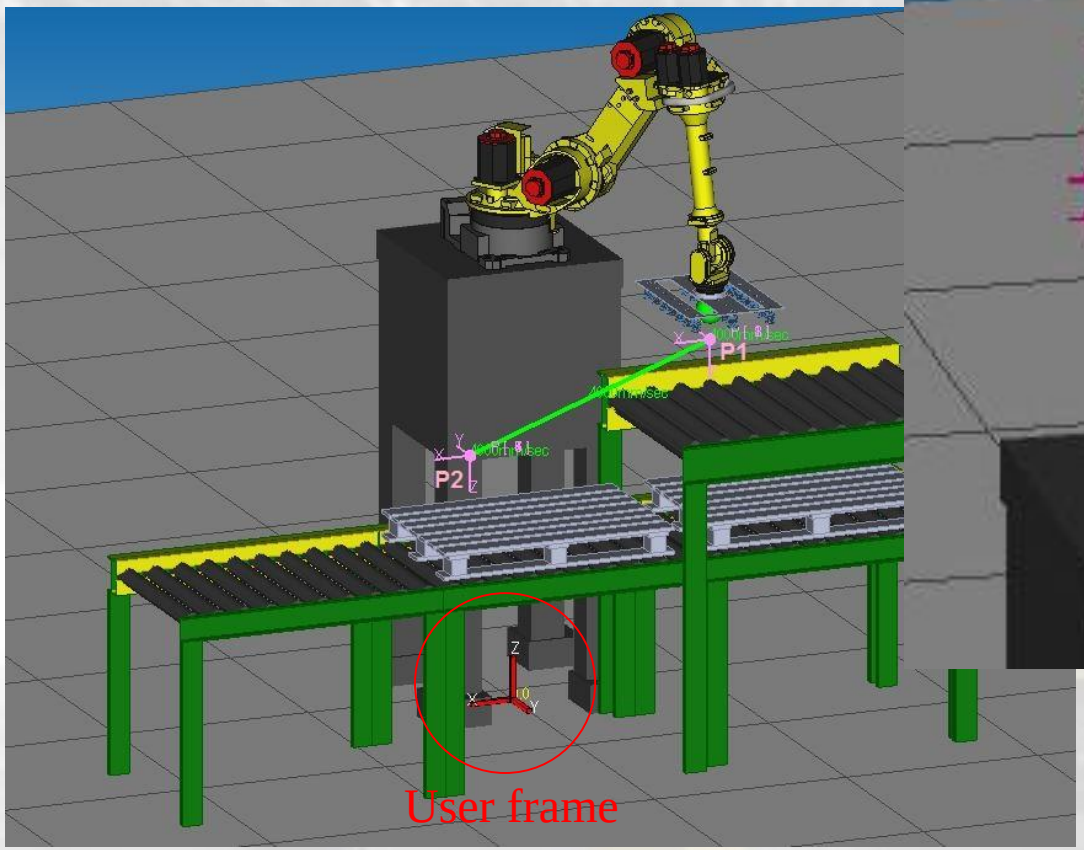
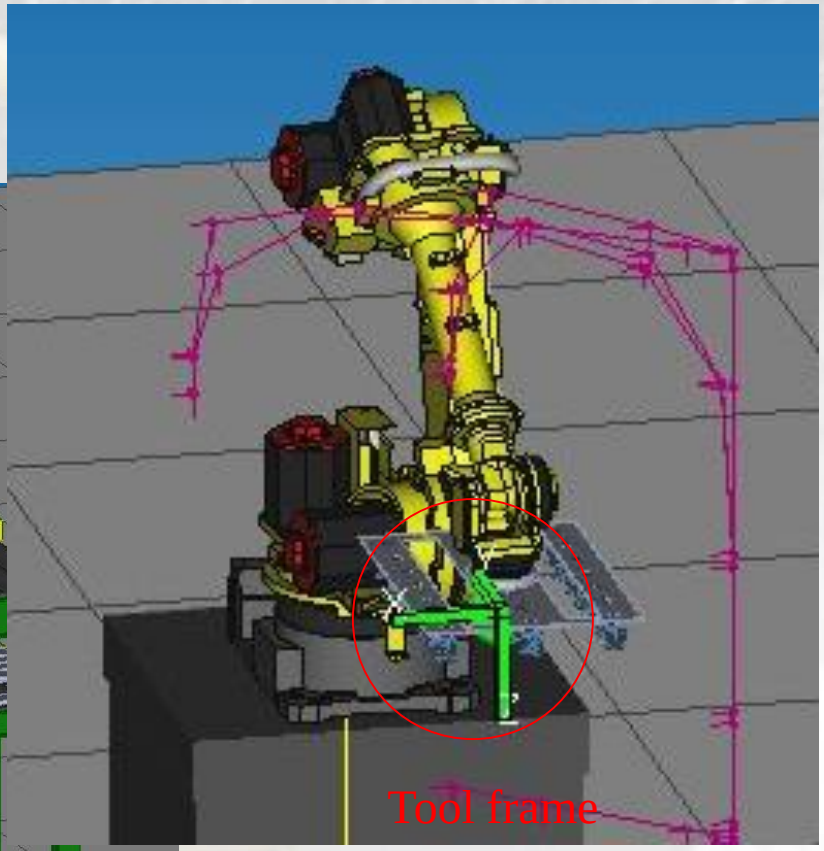
Frames





2.3 – Robot trajectory and programming

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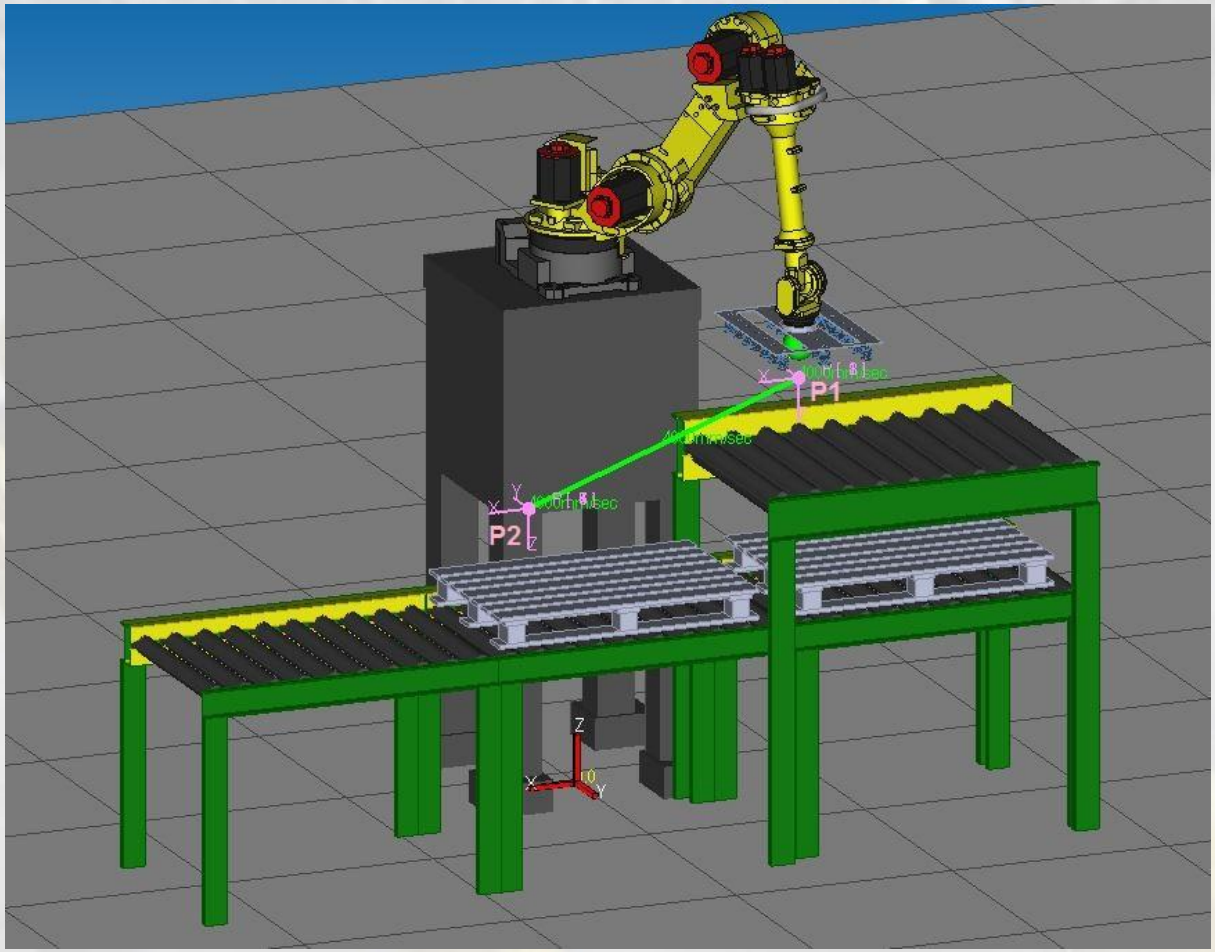
Register points



2.3 – Robot trajectory and programming

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Offsets

PR[1]	Initial point (P1 + PR[2])
PR[2]	Pick-up approach vertical distance (150 mm)
PR[3]	Collision avoidance vertical distance when picking a new box (350 mm)
PR[4]	Next-box position marker
PR[5]	Release approach vertical distance (150 mm)
PR[6]	Collision avoidance vertical distance when releasing one box in the pallet (350 mm)

2.3 – Robot trajectory and programming

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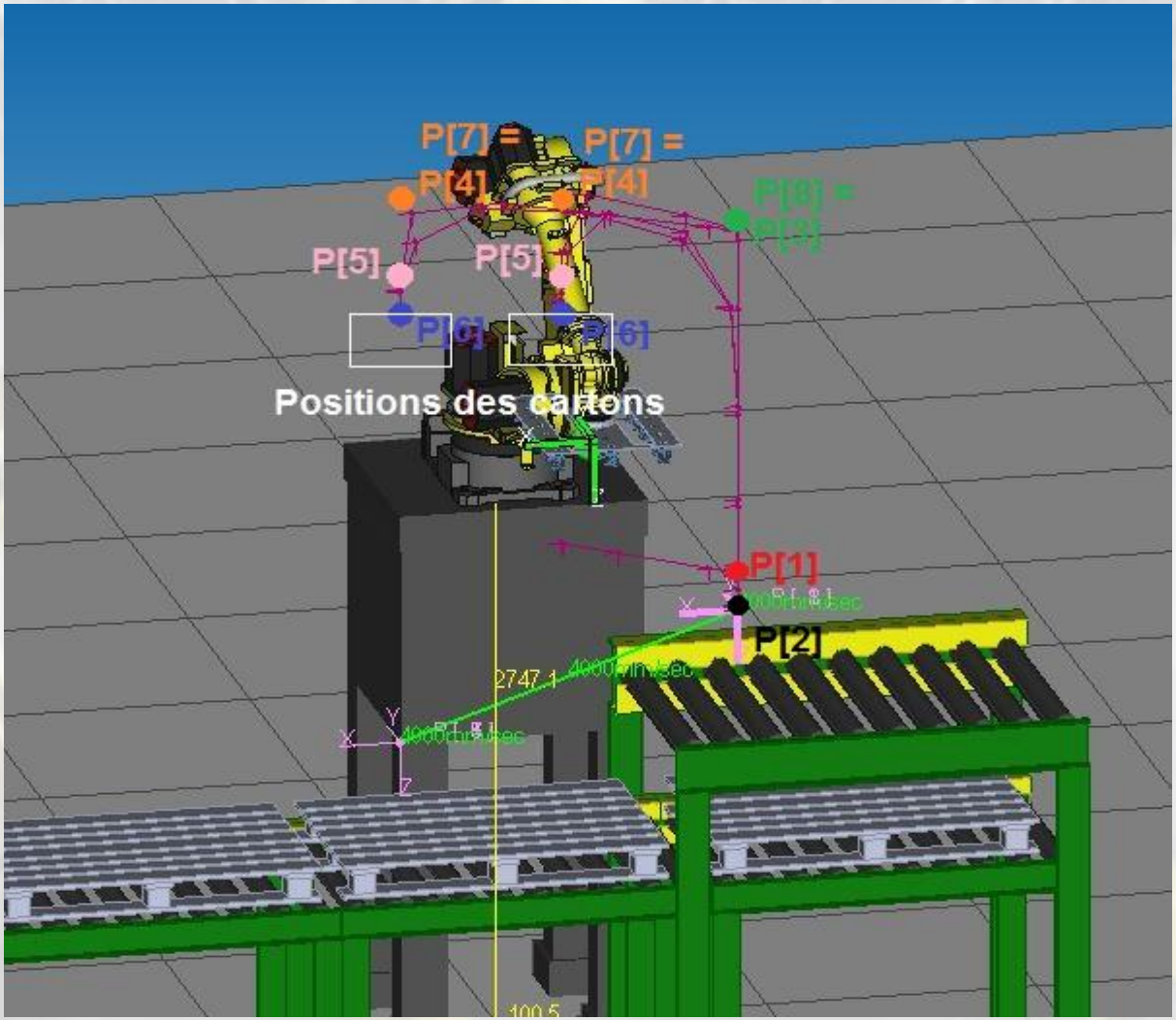
Trajectory



2.3 – Robot trajectory and programming

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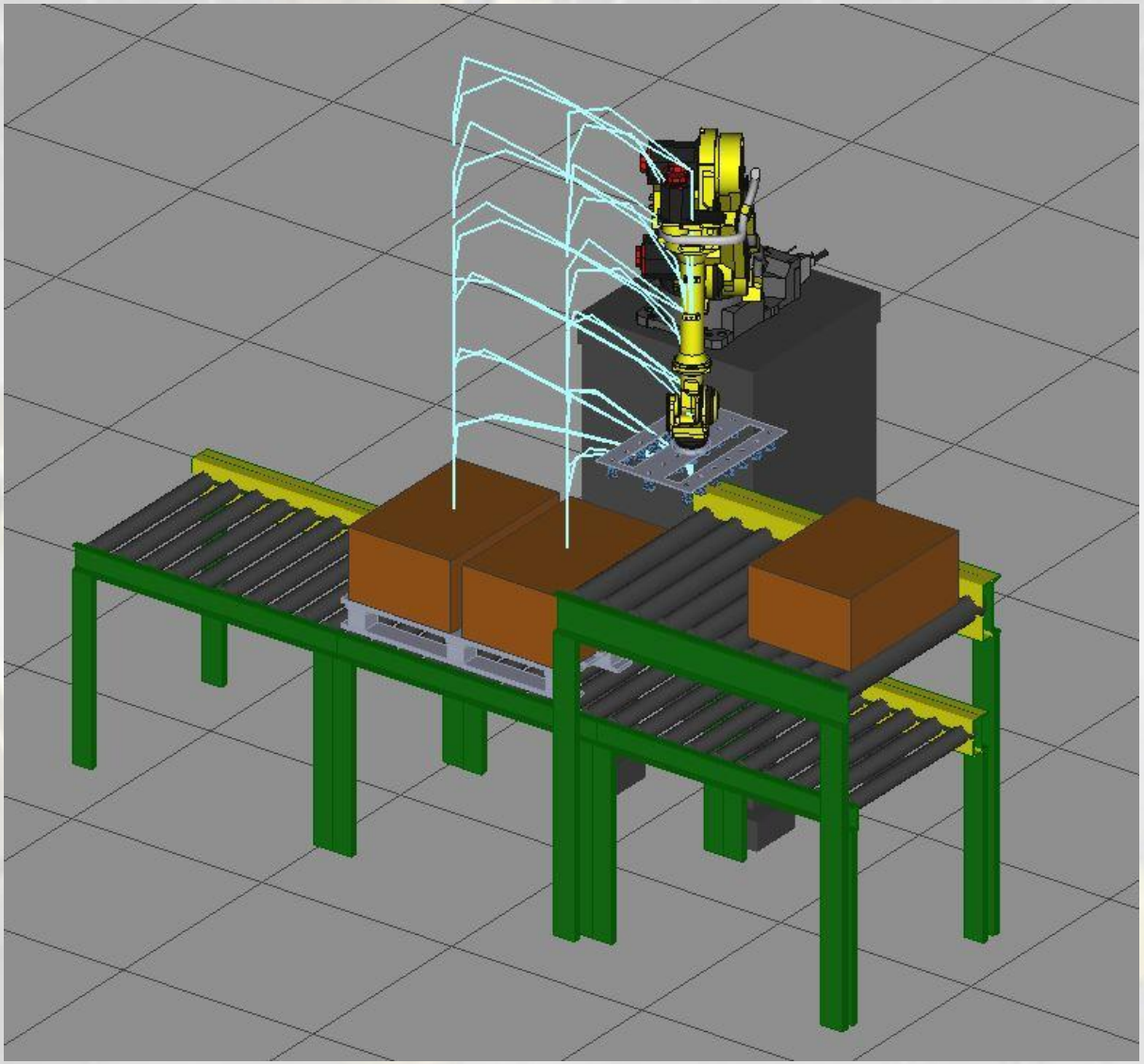
Trajectory



2.3 – Robot trajectory and programming

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Robot programming

Two programs:
- MAIN
- Prisedepose_Conv

Important issues: Payload
- (1) Empty gripper
- (2) Gripper + box

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2 – Solution description

2.1 – Robot choice;
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2.4 – Robotic cell inputs and outputs;
2.5 – Operational safety considerations.

2.4 – Robotic cell inputs and outputs

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Inputs

DI[1]	Box available to be picked
DI[3]	Empty pallet available before the charge zone
DI[4]	Pallet available to be charged
DI[5]	Charged pallet available to be removed

2.4 – Robotic cell inputs and outputs

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Outputs

DO[2]	Turn on the conveyor to take the empty pallets to the charge zone
DO[3]	Turn on the conveyor to take the charged pallets to the removing zone
DO[5]	Turn on the box conveyor to take the boxes to the pick-up position
D0[6]	Turn on/off the gripper

2 – Solution description

2.1 – Robot choice;
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2.5 – Operational safety considerations

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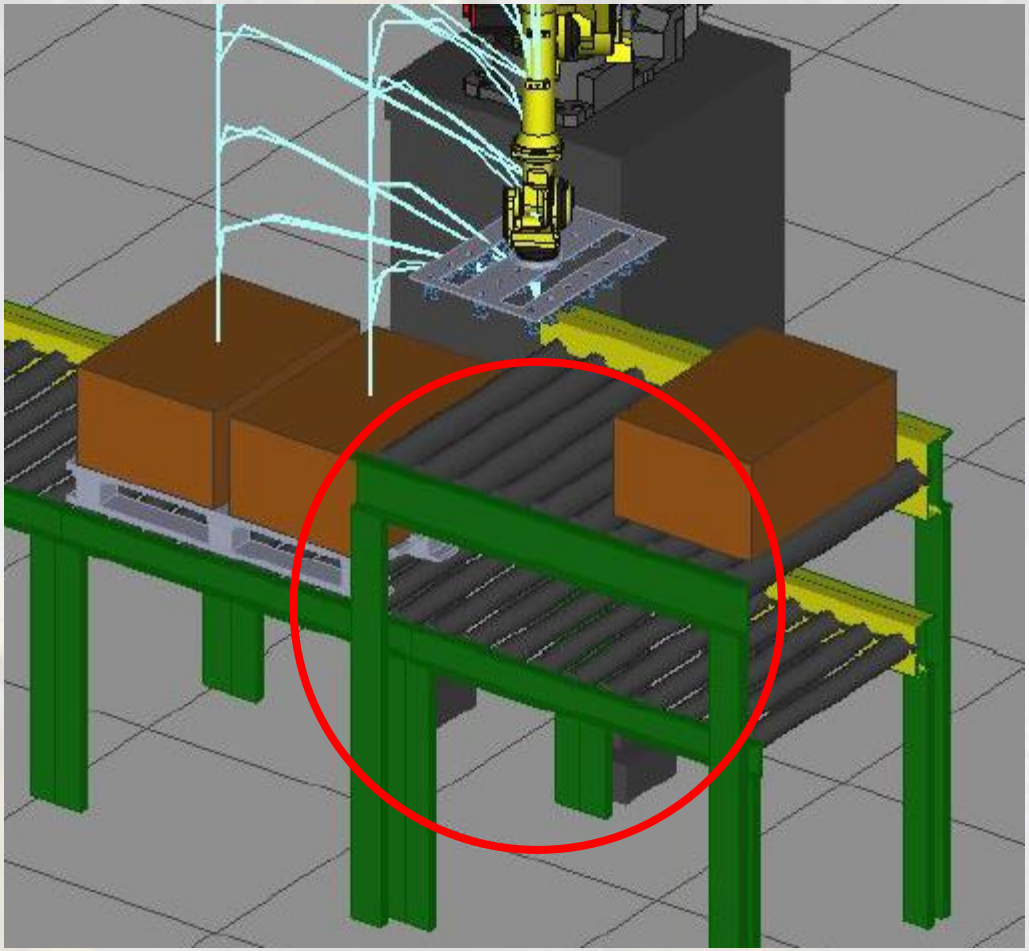
Risk assessment

- Access to the pallets
- Falling objects
- Maintenance



2.5 – Operational safety considerations

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Risk assessment

- Access to the pallets
- Falling objects
- Maintenance

2.5 – Operational safety considerations

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Risk assessment

- Access to the pallets
- Falling objects
- Maintenance

2.5 – Operational safety considerations

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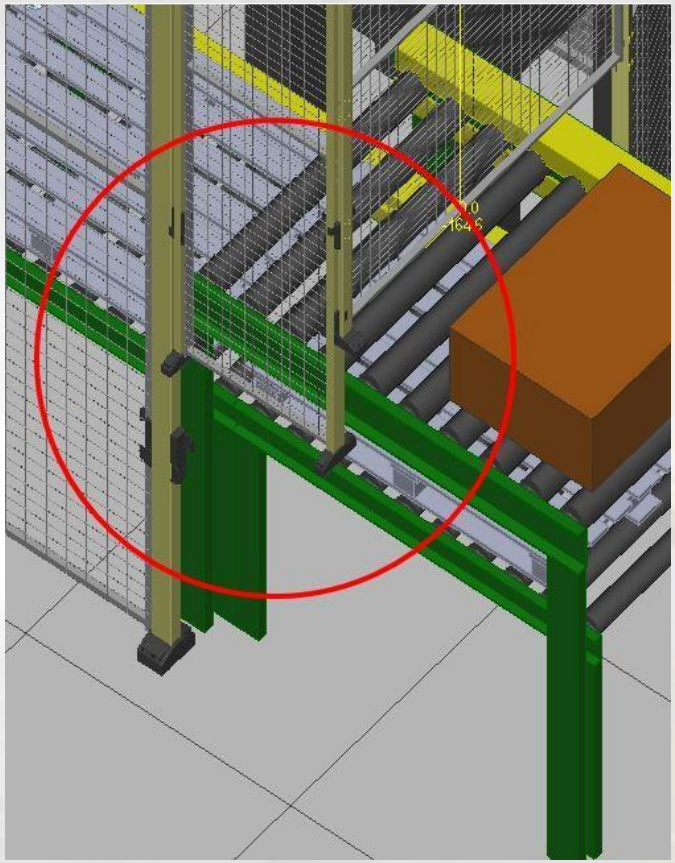
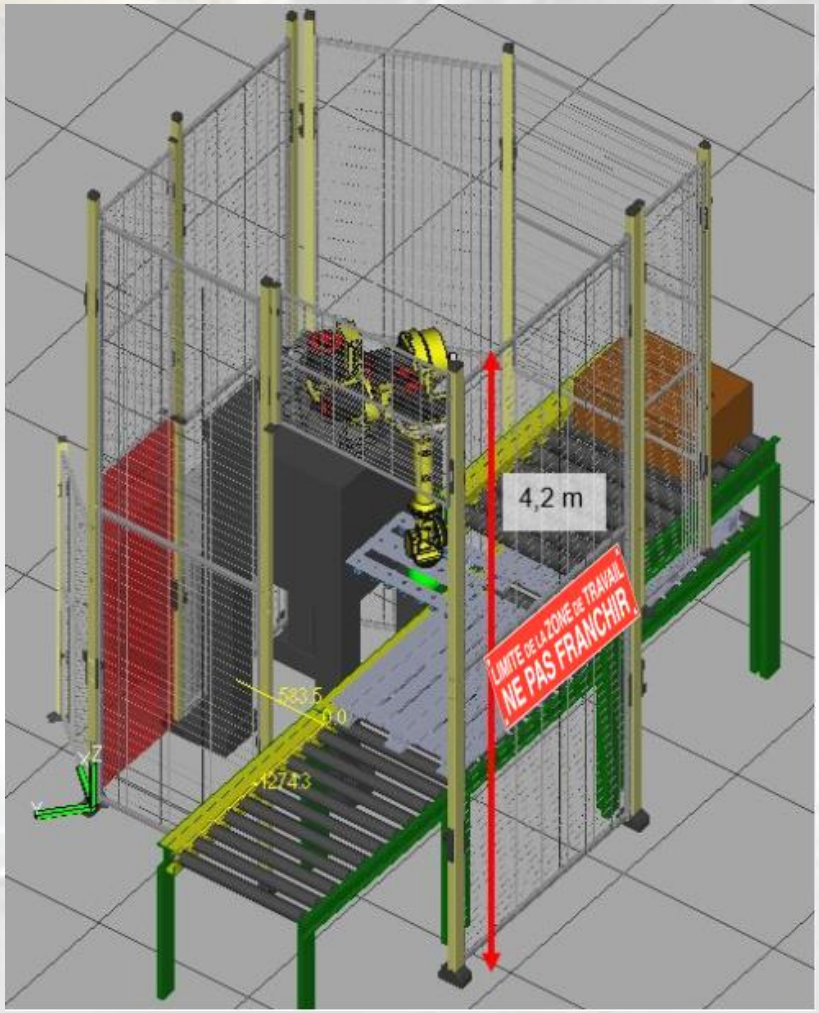
First Solution: Fence





2.5 – Operational safety considerations

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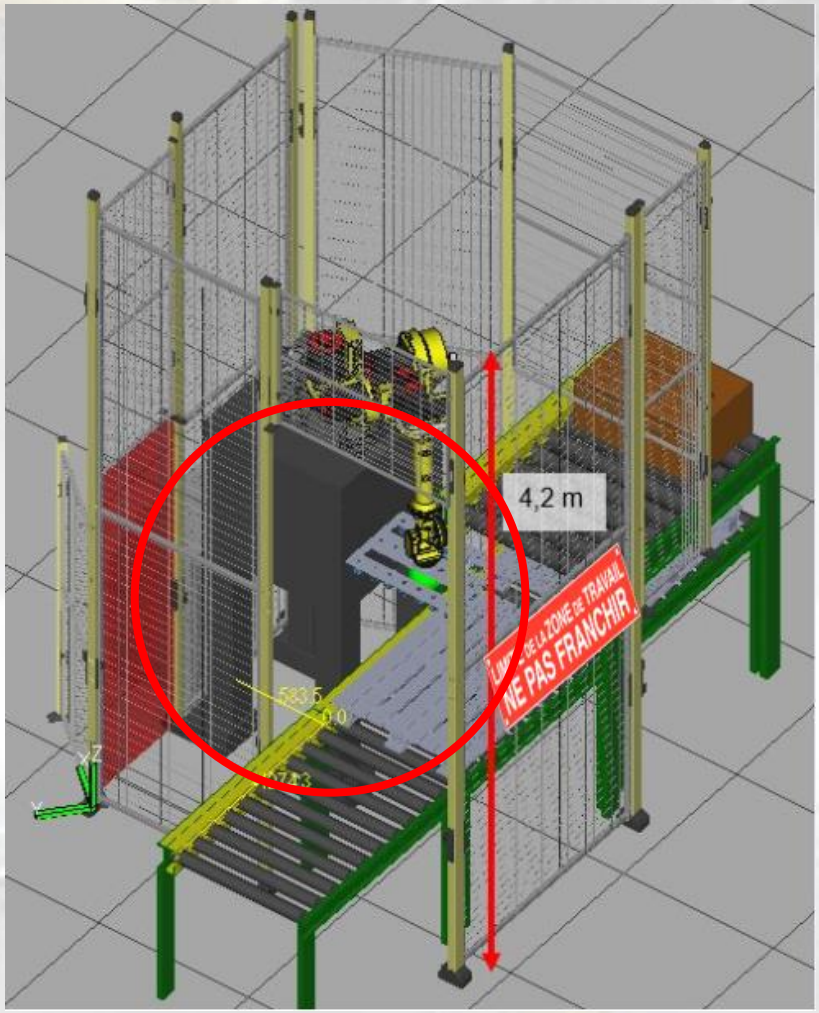
Problems:

- Lack of protection
- Fence area



2.5 – Operational safety considerations

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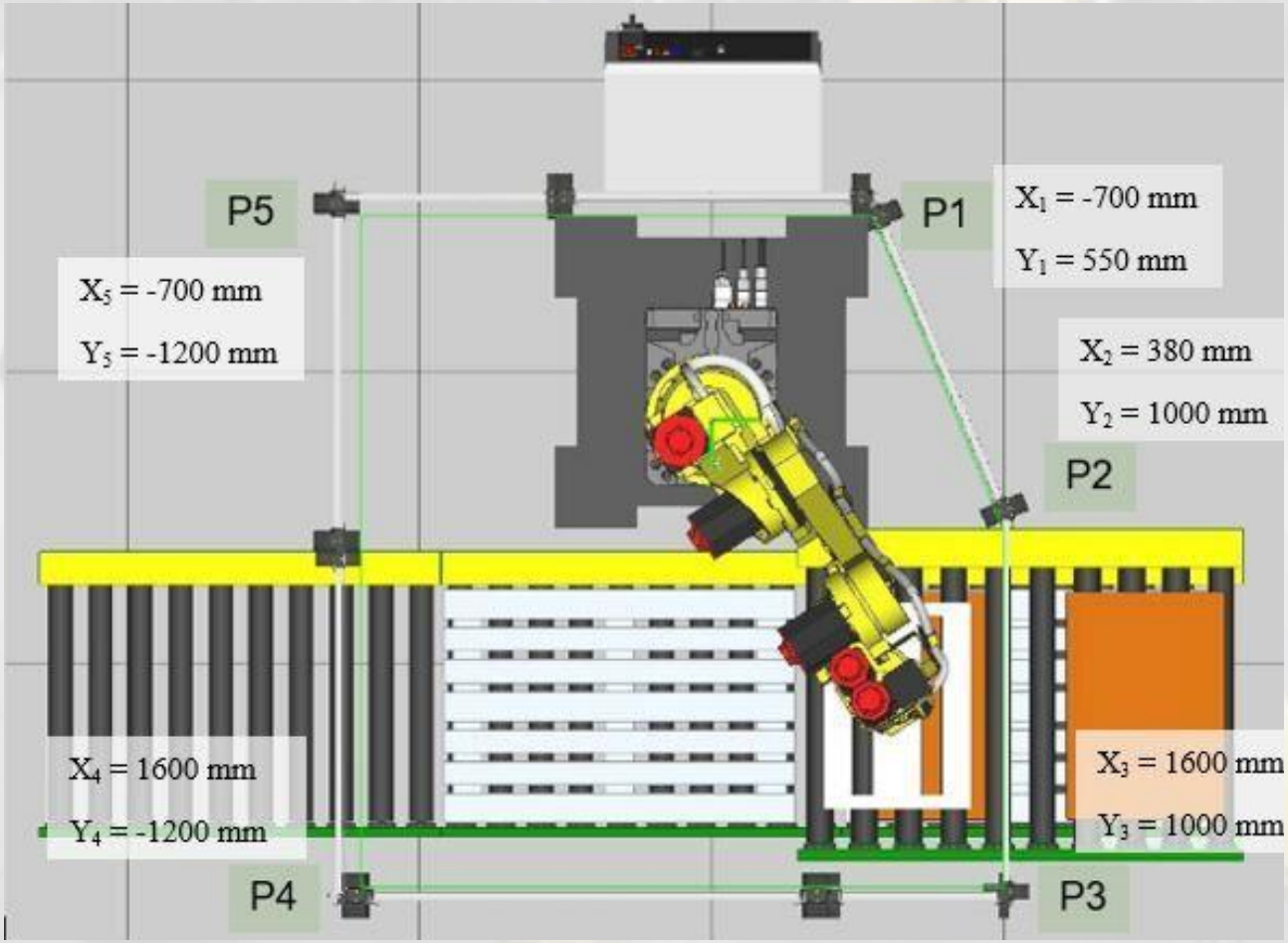
Solution: Dual Check Safety Cartesian Position Check



2.5 – Operational safety considerations

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Solution: Interlock Switch

3 – Results & Performance

3.1 – Security;
3.2 – Surface;
3.3 – Production Throughput;
3.4 – Budget.

3.1 – Security

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Compliance with ISO 13849-1:

Assessed sources of Risks

↓

Evaluation of the risks posed by each one (PLr)

↓

Is the proposed solution adequate (PL ≥ PLr)?

3.1 – Security

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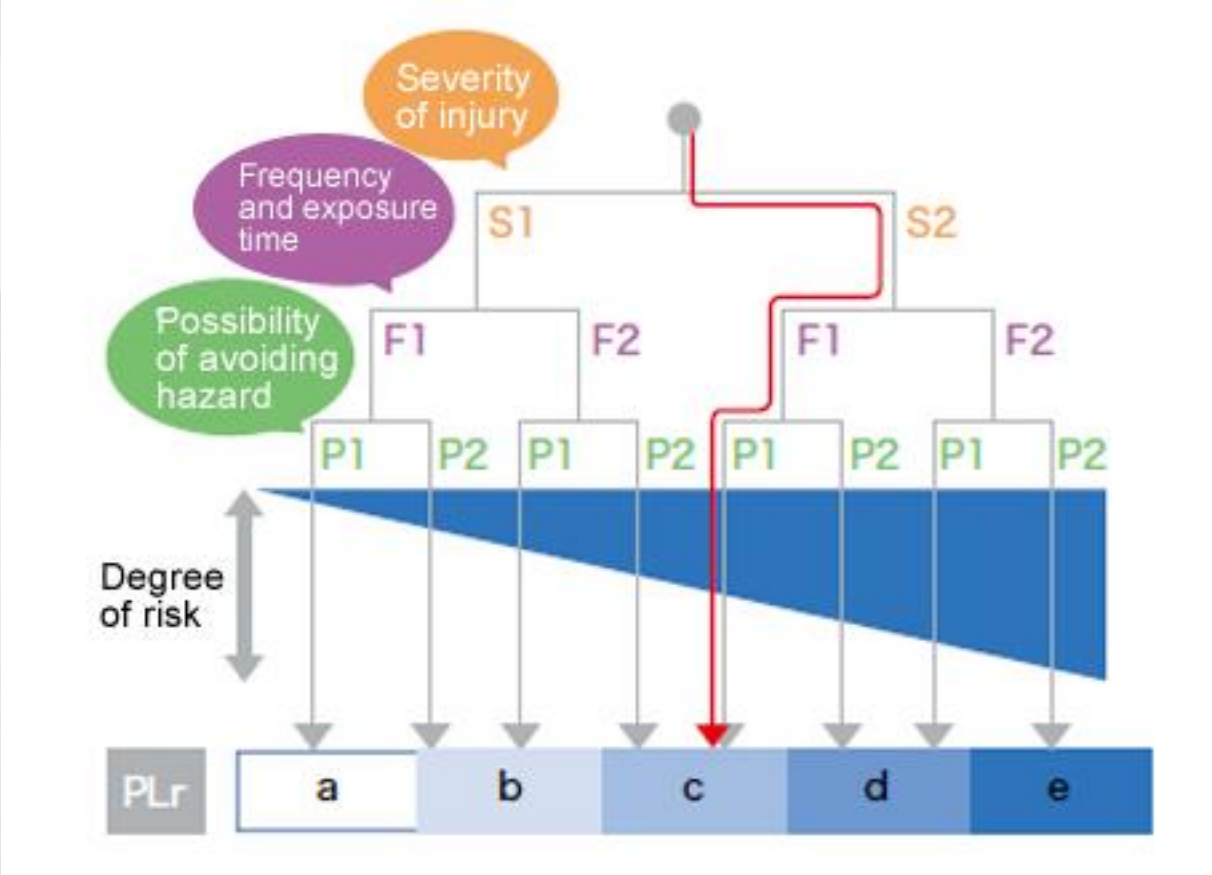
Compliance with ISO 13849-1:



3.1 – Security

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Compliance with ISO 13849-1:

Source de Risque	S	F	P	PLr
Accès des palettes	S2	F2	P1	PLd
Maintenance	S2	F1	P1	PLb
Chute d'objets	S1	F2	P1	PLb

3.1 – Security

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Compliance with ISO 13849-1:

Function name	**Standard/Optional**	**ISO13849-1/IEC61508**
Joint Position Check Function	Option A05B-2600-J567	Category 3 PL d SIL 2

3 – Results & Performance

3.1 – Security;
3.2 – Surface;
3.3 – Production Throughput;
3.4 – Budget.

3.2 – Surface

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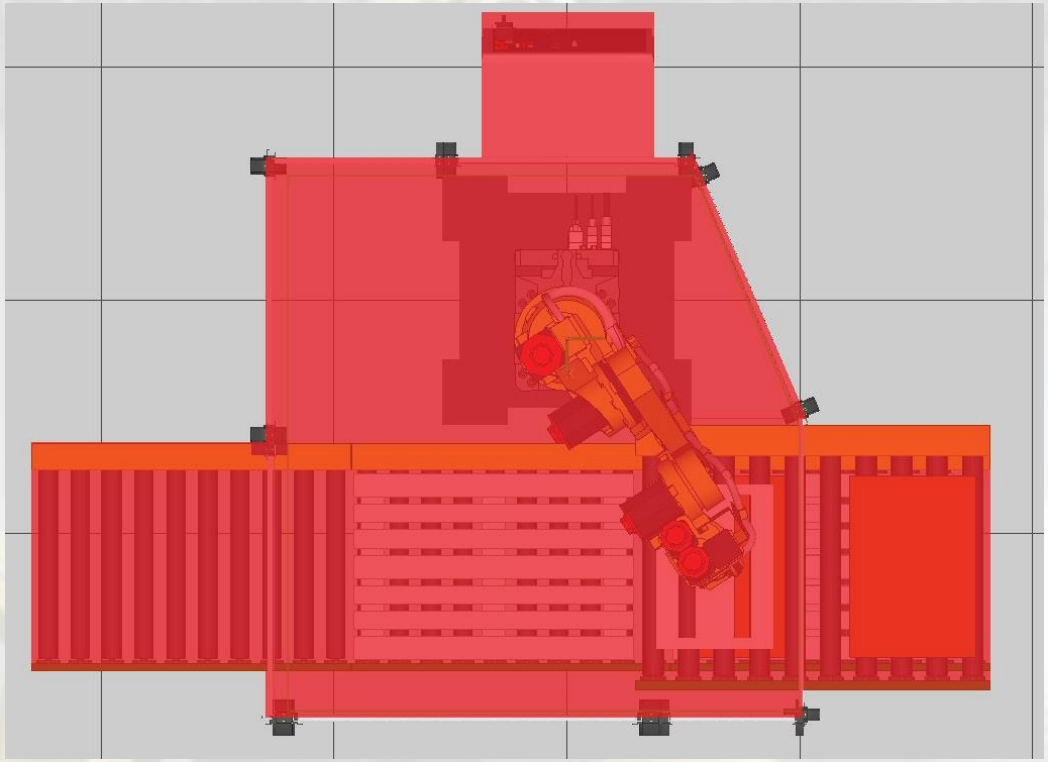
Total Area: **7.47 m²**

Equivalent to 57.61% of initial area



3.2 – Surface

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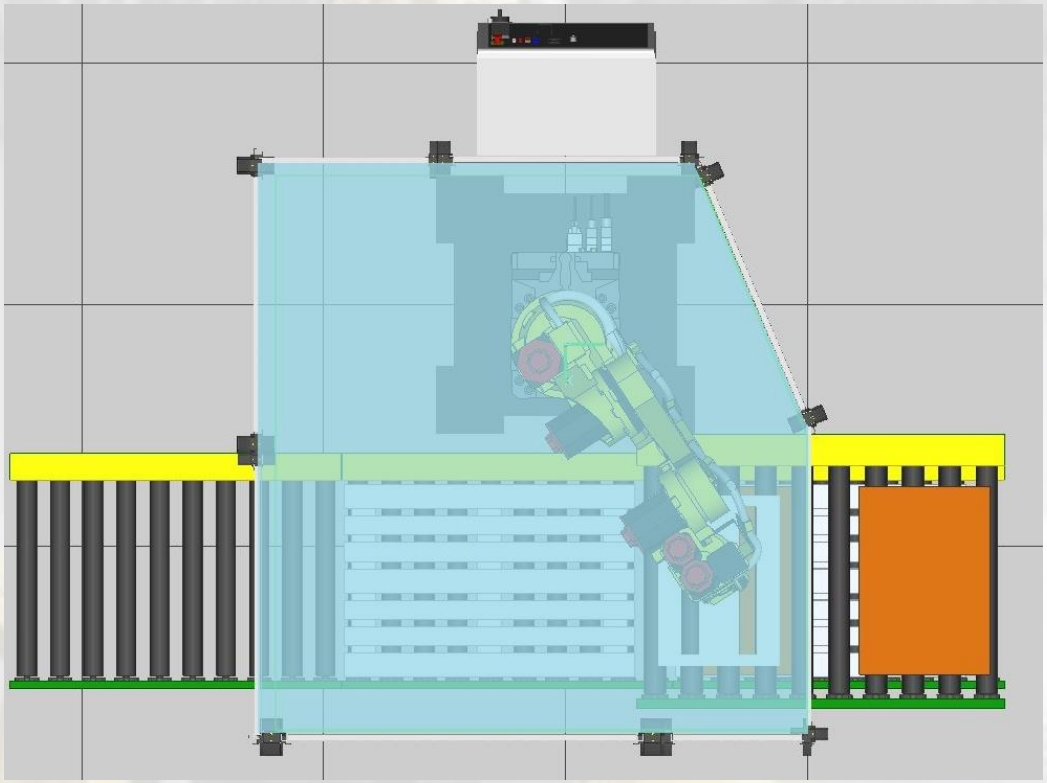
Working surface: **5.33 m²**

Equivalent to 41.14% of initial area



3 – Results & Performance

3.1 – Security;
3.2 – Surface;
3.3 – Production Throughput;
3.4 – Budget.

3.3 – Production Throughput

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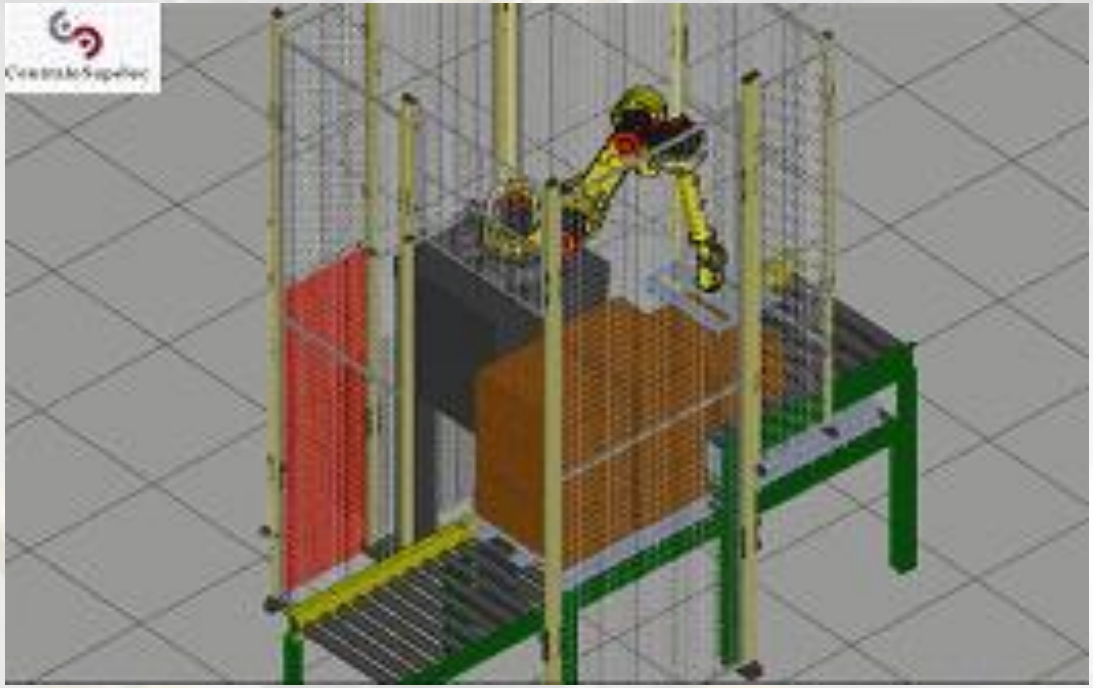
720 boxes / hour *

About 75% more than the original cell throughput



3 – Results & Performance

3.1 – Security;
3.2 – Surface;
3.3 – Production Throughput;
3.4 – Budget.

3.4 – Budget

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Robot R-1000iA/80H + R-30iB Controller and DCS Module

About 45000 + 2000 €

3.4 – Budget

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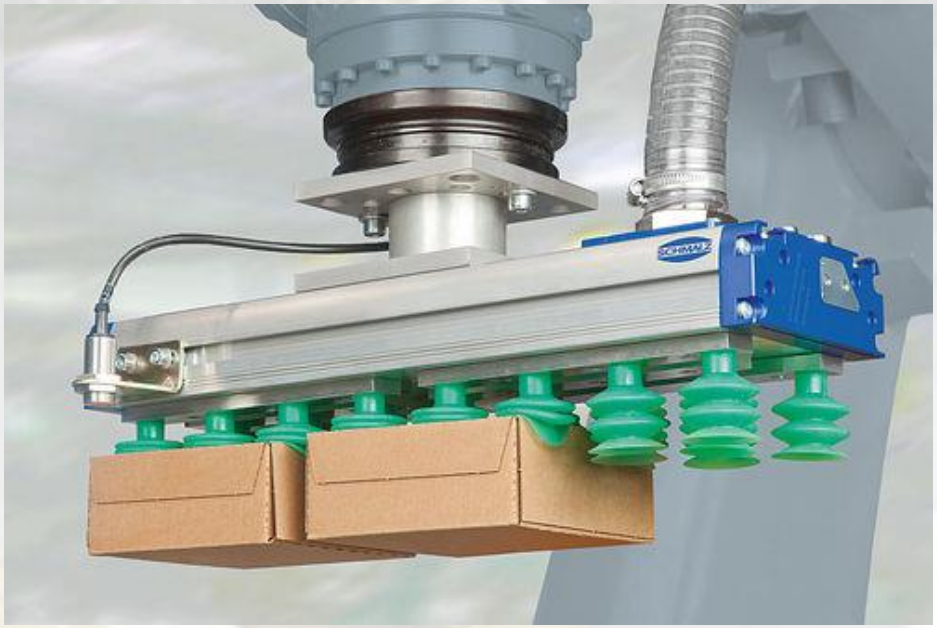
Suction Gripper

About 700 €



Merely illustrative

3.4 – Budget

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Elements	Price
Robot R-1000iA/80H	45000 €
DCS Module	2000 €
Suction Gripper	700 €
Total	47700 €

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4 – Conclusion

- Faster than expected
- Considerably cheap
- Less than 50% of initial surface
- Software maintainability

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Thank you for your attention!

Any questions?