asyril Experts in Flexible Feeding Systems

# FEASIBILITY STUDY REPORT

FAI_1991_TRI

Phase I

| | | | |
|---|---|---|---|
| Effected by | CtL / PuV | Company : (customer, contact) | feno GmbH |
| Delivery date | 18.01.2023 | | Lothar Schmidmayr |
| | | | lothar.schmidmayr@trimatec.com |

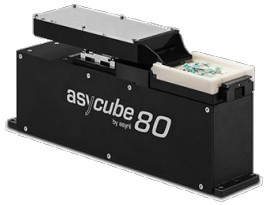
# Feasibility Goal

Solution requested : **Feeding & Vision**

Desired Cycle time : **1 parts / 3 sec fixed time**

Asycube 50

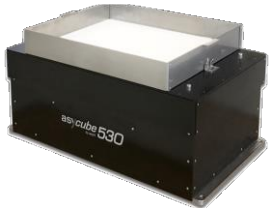

Asycube 80




Asycube 240


Asycube 380


Asycube 530

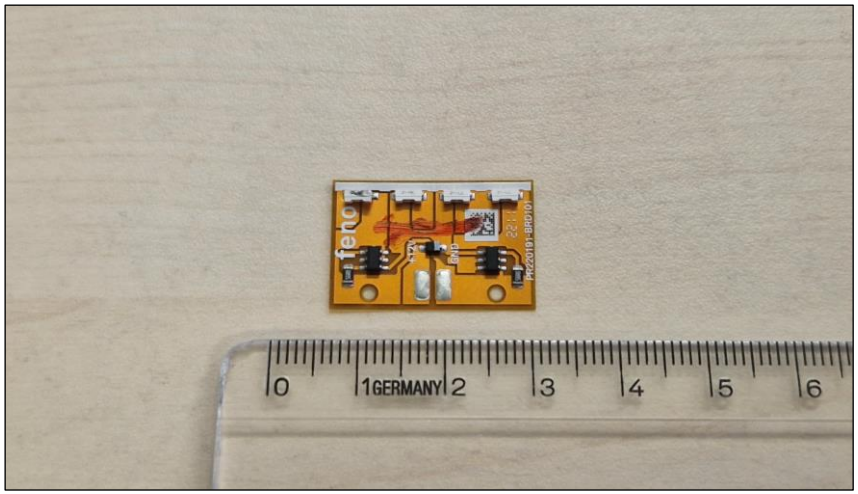




☐ Not Asked

☑ **EYE+ 6.3 MPx**

Component to test :




Additional info

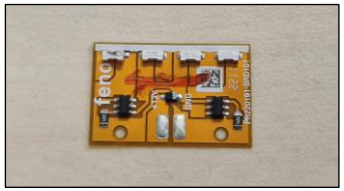
The picking orientation is shown in the picture aside (components facing upwards).

The parts are picked by a vacuum gripper Ø4mm.

The system can have 2 feeders to avoid the robot waiting on pickable parts.

# General Results

**PCB**



| Vibration | | Vision | | Estimated cycle time* | |
|---|---|---|---|---|---|
| **OK** | | **OK** | | **OK** | |
| **Asycube size :** | 380 | **Camera resolution :** | 6.3 MPx | **Ratio of good parts** :** | 6,90 / 28 |
| **Platform :** | Flat | **Lighting :** | BL Red | **Feeding duration [s] :** | 1,95 |

| | |
|---|---|
| **OK** | Results were good. |
| **TO DISCUSS** | Some conditions have to be respected in order to have good results. |
| **NOK** | The goal will not be reached. |

* The Cycle time is estimated by counting the No of available part after vibration (20 times)
** Avg. No. of good parts / number of parts on platform

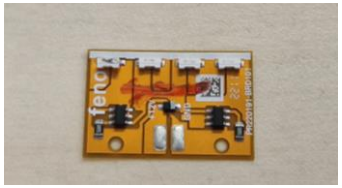
# Global Remarks

- The Asycube 380 can spread and flip the parts. For those parts, the low frame is sufficient to avoid parts jumping out of the platform. A flat white platform has been used.

- EYE+ can detect and define the orientation of the parts using the backlight only.

- With a very fast robot and a very good integration , one Asycube 380 could even be enough to reach the desired cycle time of 1 part every 3 seconds. Otherwise using 2 Asycube will make sure the cycle time is  reached.

# FAI_1991_TRI
# Prints - Results



## Test configuration

**Vibrations**

| | |
|---|---|
| Product | Asycube 380 |
| Plate type | Flat |
| N° | 000.102.555 |

**Vision**

| | |
|---|---|
| Camera | Eye+ 6.3MPx Short |
| Lighting | Backlight |
| Color | Red |

## Advised configuration

☑ Same as test configuration

☐ Other

## Test result

| Step | Desired Performances | Achieved Performance & Remarks |
|---|---|---|
| OK **Vibrations** | Orientation shown at the top of the slide. | • **Frame :** The low frame is sufficient to keep the parts on the platform.<br>• **Spreading :** It is possible to flip and spread the parts.<br>• **Orientation :** It is possible to orient the part as desired. We used a flat white platform to avoid having height differences between the parts for the picking operation.<br>• **Caution :** During the feasibility study, no damages have been seen on the PCB but to avoid it, the vibrations amplitude should not be too high.<br>• **Video(s) :**<br>➢ FAI_1991_TRI - Prints.mp4 |
| OK **Vision** | X, Y, Rz of parts<br>Pick side detection | • **Lighting :** We recommend to use the standard red lighting. We used backlight only.<br>• **Resolution :** We used the 6.3 MPx camera.<br>• **Working distance :** Both long and short working distance can be used. We advise to use the long one.<br>• **Vision Model :**<br>➢ **Detection :** The detection is possible with a backlight picture.<br>➢ **Selection :** This step can be skipped as the top/down detection can be strongly achieved by the pick point algorithm.<br>➢ **Pick point :** We used the mask to erase some features and some noise to focus on important details to increase the precision of detection. We used a backlight picture.<br>➢ **Pick Angle :** Same remarks as pick point. We used a backlight picture. |
| OK **Cycle time** | 3,00 seconds / part fixed | **Nbr of feeding sequences possible in 1 cycle** 1<br>**Occurrence of feeding time exceeding the CT to get 1 part** 0%<br>**Nbr of time no parts ready after 1 feeding sequence** 0<br><br>**Nbr of parts on the plate**<br>**Min : 4**<br>**Max : 12**<br>**Mean: 6,90**<br>**Feeding duration: 1,95 s**<br><br>With a very fast robot and a very good integration., one Asycube 380 could even be enough to reach the desired cycle time.<br>Indeed, the sequence (vibration + picture) take 1,95 seconds. If the integration is well done, we can even start the vibration in parallel of the "place step" of the last part. As we always had some parts available after a sequence , with a fast robot the cycle time could be reached.<br>Otherwise using 2 Asycube 380 will ensure the cycle time is reached . |

# Prints - Cycle Time Results

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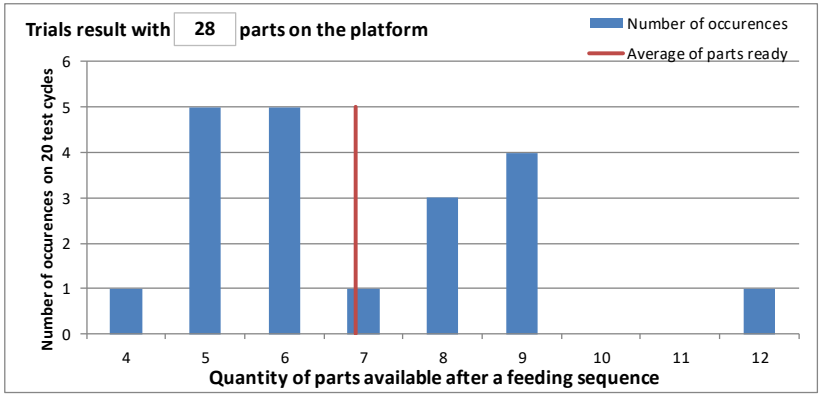
## *RESULTS of feeding trials*

| | | | |
|---|---|---|---|
| Quantity of parts on the platform | | **28** | [parts] |
| **Quantity of available parts after vibration** | **Mean** | **6,90** | [parts] |
| | Min | 4 | [parts] |
| | Max | 12 | [parts] |
| Feeding sequence duration | | **1,95** | [s] |

### *Feeding sequence*

| | Vibration | Duration | |
|---|---|---|---|
| 1 | hopper QTY ADJUSTED | 250 | ms |
| 2 | plate CENTERING MAX | 500 | ms |
| 3 | plate FLIP | 300 | ms |
| 4 | STABILIZATION | 600 | ms |
| 5 | | | ms |
| 6 | | | ms |
| 7 | | | ms |
| | IMAGE acquisition & analysis | 300 | ms |

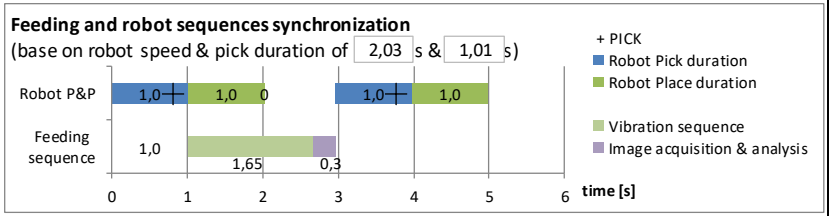



The **histogram** shows the quantity of available parts after vibration and their occurences considering 20 successives feeding trials. After each trials all good parts were picked and placed back in the hopper.

## *Averaged cycle time (assessment)*

**Goal:** **20** **[parts/min]**

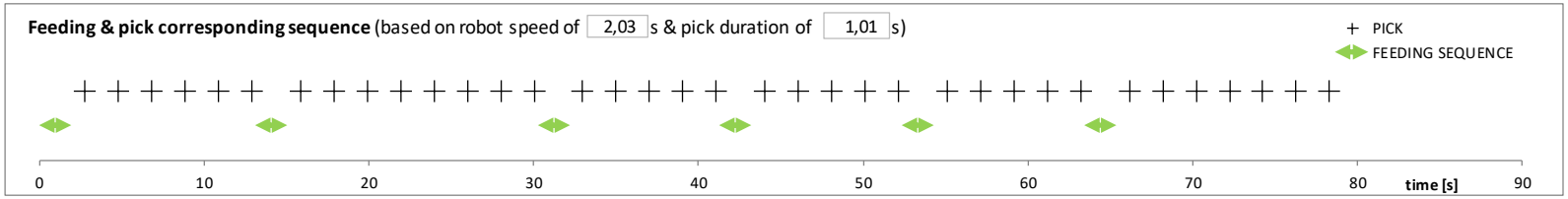
| | Robot cycle time [s / pick] | Robot pick duration [s] | Estimated cycle time [parts / min] | Performance achievement |
|---|---|---|---|---|
| Estimations are based on the following robot speeds: | ***2,7*** | ***1,35*** | **21,5** | **OK** |
| | *2,0* | *1,01* | **27,8** | **OK** |
| | *1,4* | *0,68* | **39,1** | **OK** |




The **robot pick duration** corresponds to the time laps from the moment the robot gets the coordinates of the parts to pick until when the feeder can vibrate again.

In other words : the robot pick duration is equivalent to the time the feeder can not prepare a new part (no vibration, no vision).

The shortest the pick duration is the fastest the cycle time can be. In general we consider the pick duration as half the robot cycle time.

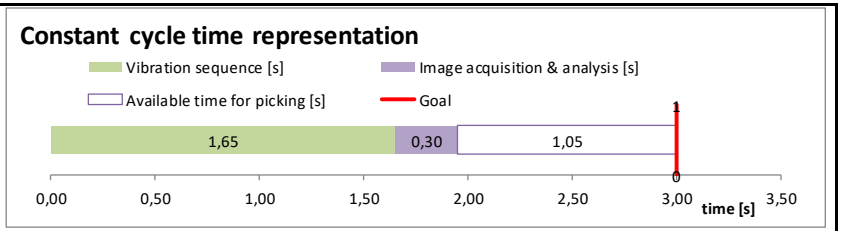



## *Constant cycle time (assessment)*

**Goal:** **1** **part(s) each** **3,00** **seconds**

| | |
|---|---|
| Number of feeding sequence(s) possible in 1 cycle | 1 |
| Rate of occurrence of "waiting on the feeder" | 0% |

**Conditions looks good to achieve the goal. Look to the minimum quantity of available parts to evaluate the level of risk of no part available on time and verify that the available time for picking is sufficient for your application and for the robot.**




The **rate of occurence of "waiting on the feeder"** is based on the occurence of "no parts available after vibration" within the constant time (we consider the case of successive vibrations if this is possible during the timing). The rate gives information about the risk of occurence of the robot waiting on the feeder.

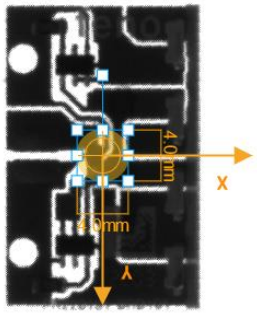
# Prints - Final Vision Results

## Global Results

For the study, we considered the above picking area. In means we considered the robot able to pick part inside the region defined by the red lines.

*Nota : Reduced working area might have a non-negligible impact on the cycle time.*

## Gripper Exclusion Zone




The orange area above represents the robot gripper exclusion zone. This space needs to be clear to ensure the robot gripper has proper clearance to pick the part without disturbing nearby or the platform border.

*Nota : Zone shown above was used for the study. Actual gripper exclusion zone used in production may vary.*

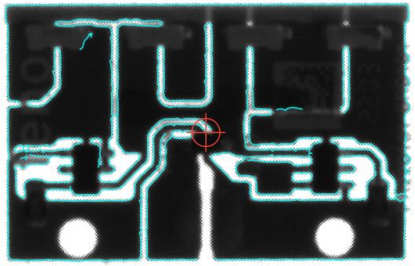
# Prints - Vision : Step 1, Candidates Detection

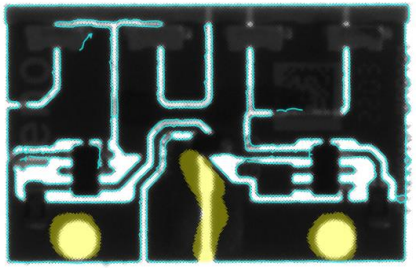
This step use a segmentation tool to create groups of pixels (blob). By filtrating them by size, it is possible to pre-locate potential good parts.

# Prints - Vision : Step 3, Pick Point teaching

**Pick Point Results**

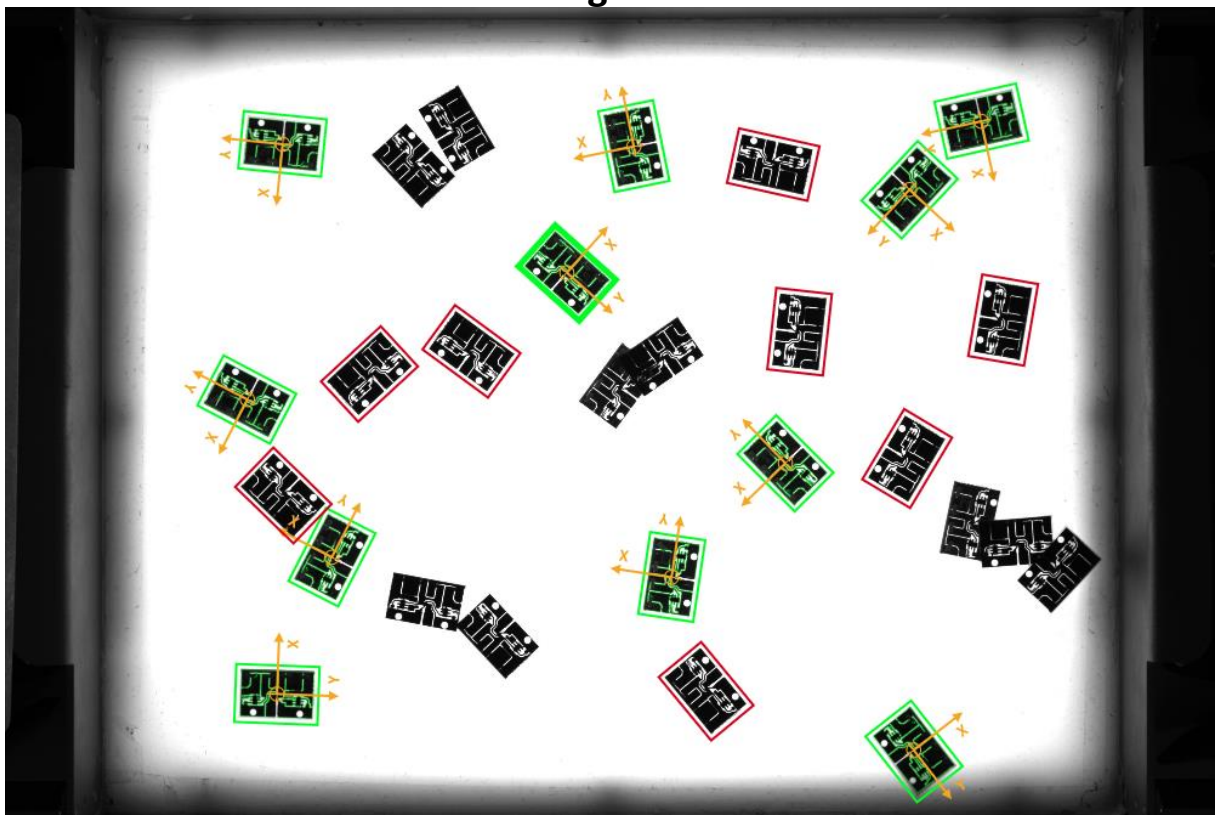
**Pick Point Model**



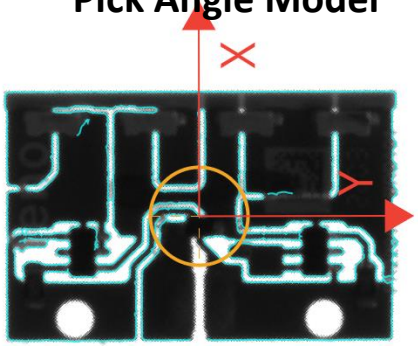


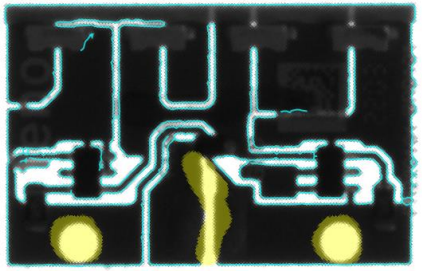
# Prints - Vision : Step 4, Pick Angle teaching

**Pick Angle Results**



**Pick Angle Model**





# Remarks – Cycle time study

**The results of this study are for information only and can be used to estimate the cycle time considering the following aspects:**

- The results are based on statistics and the process of feeding with a smart feeder is stochastic. Thus we can not exclude the situation of having less or no parts available sometimes in the production cycle.
- The results assumes **that the Asycubes are separated sufficiently** in order that the robot does not hide the field of view of the other Asycube during the pick and place trajectory (or any other movement).
- The results assumes that it is **not necessary to take a new picture after each pick** (in that case, the corresponding duration should be added each time).
- The robot will start picking as soon as parts are available on the first or second Asycube. This **initialization can exceed the clock duration**.
- We assume there **are sufficient parts in the hopper** to have a stabilized and continuous feeding. If no more (or less) part are available (for example at the end of the production batch) or too much parts are fed on the Asycube, the conditions are no more respected and the cycle time will be clearly slower.
- The **stabilization** duration cannot be validated by this test. The final value will also depend on the precision required by the application.
- The **picking zone was considering as the whole surface of the plate**. If necessary to limit this area (too close of any border for example), the amount of available parts will potentially be reduced => potentially slow down the cycle time
- **No consideration of the shape/size of the gripper** : a good part does not touch another part or border, but there was no other exclusion area that filtered the results. If any distance is necessary, this will potentially decrease the number of available parts => potentially slow down the cycle time.
- **The duration dedicated to the robot to pick the part is never included in the study.**

In each case, there is always the need but also the possibility to optimize the vibration sequence in the final machine as it is impossible to simulate the whole process in the feasibility study.

# Remarks – Vision Analysis

**The results of this study are only valid within the condition of test related here. Any modification of them may impact the final performances of the feeding and detection.**

- Only the good detection of the parts were tested. No consideration of precision, inclusion of specific parameters due to the gripper or the machine were taken in consideration.
- If no indication was given, the definition of the picking position was always taken at the center of the parts and never aligned with a specific detail. Picking height and detail detection might influence the way to configure the vision detection, the necessary camera resolution as well as the calibration procedure.
- The Asycube pick camera cannot be used to make quality control of parts due to low resolution
- Protections against external light sources are required as they can disrupt the detection quality.

# General remarks

- Asyril will store all received material and parts for a 1 year from the date after the feasibility is closed. The material / parts will then be recycled.
- Asyril reserves the right to keep some material / parts for their records and possibly for training purpose.
- If specific recycling cost are incurred, Asyril reserves the right to send back material / parts to the customer at customer's expense.
- The customer can request that material /parts be returned at customer's expense.