Engineering a delightful world.

Quality Yield Cockpit

A system that ensure expected quality by maximising yield

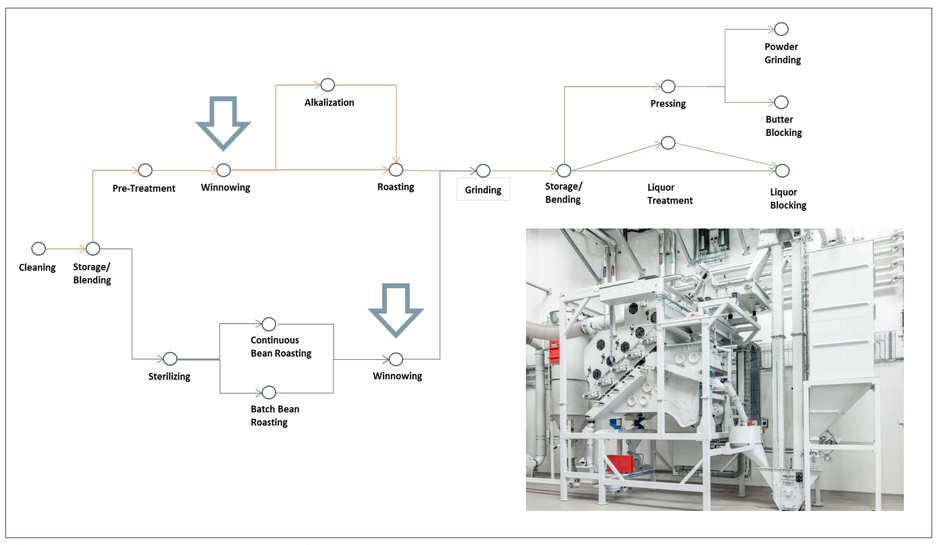

Figure 1: Cocoa Processing Landscape

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Starting from bean cleaning (left) to the finished products (right)
The classical way of nib roasting including the optional alkalization is marked in orange.
The bean roasting line including the bacterization process is marked in grey.

Both roasting lines requires a separation of the cocoa from shell using a winnower device (arrow).
The winnowing process step is a key regarding of quality monitoring (e.g. shell content in nib < 1,75%) and cocoa yield (e.g. < 0,5% nibs in shells) within a cocoa processing plant.

So, fare of the de-shelling system is analog and controlled by one sampling person every 7 hours. Within these 7 hours, product quality as well the environmental parameters might variate and causing undetected changes within the winnowing system which have an important impact on quality and yield.

Therefore, a new system called **"Quality Yield Cockpit" (QYC)** was invented.
The QYC allows to detect the changes and act accordingly online. In this way, the desired quality can be managed and the yield optimized.

Processing data has shown that an additional gain of up to 20-30 € per processed tone of cocoa can be archived by correct adjustment and monitoring of the winnowing device.

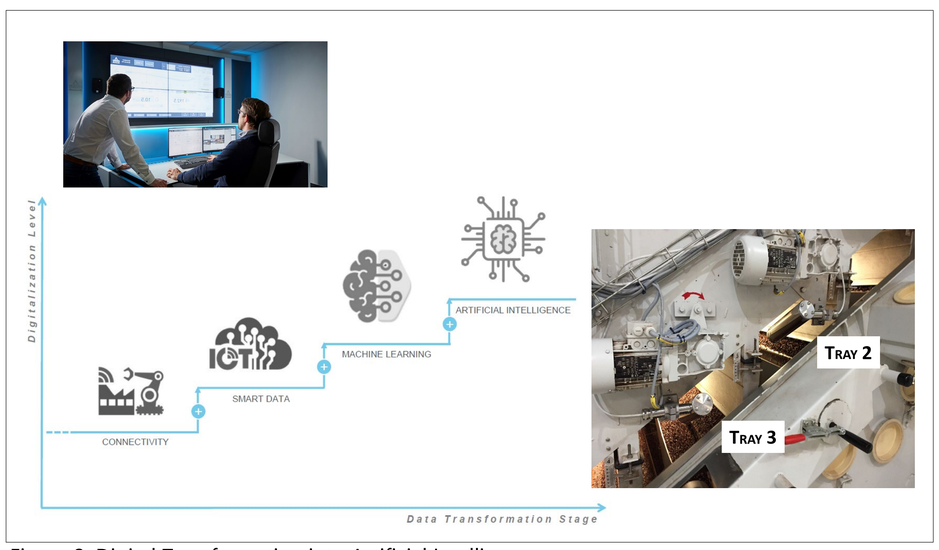

Figure 2: Digital Transformation into Artificial Intelligence

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Digital transformation from process systems via essential interim steps from analogy connectivity to an artificial intelligence solution. Picture on the left shows a Winnower that is required for separating the cocoa kernel from the cocoa shell. The picture section show the sieving "Tray 2" and "Tray 3" including a camera system.
The camera including the new developed software enables to detect the shell content in nibs during the whole separation process.
The system is called **Quality Yield Cockpit (QYC)** since it allows to react on time to meet required quality by maximizing the yield.

Quality Yield Cockpit (QYC) for winnowing
The QYC-System is the first system allowing a continuous online monitoring of a winnowing performance regarding yield and quality management.
Traditionally an analog hand sampling and counting one time per shift was done to analyse the winnower performance. The **Quality Yield Cockpit** enables to react on raw material fluctuation and environmental changes that impacts the quality and yield on time.

The **QYC- System** ensures two main targets:
- Food Safety
- Maximizing Yield by keeping expected quality

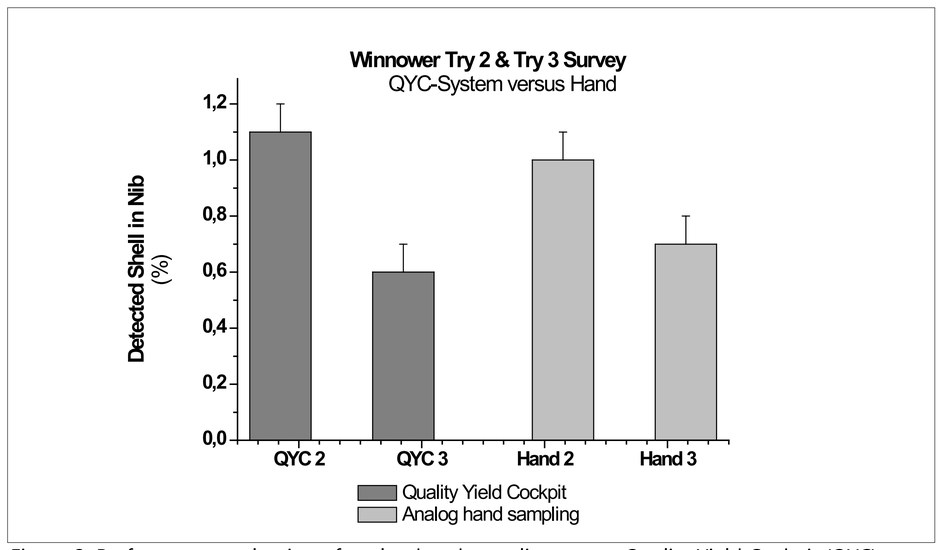

Figure 3: Performance evaluation of analog hand sampling versus Quality Yield Cockpit (QYC)

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QYC 2 and QYC 3 reflects the tray 2 and tray 3 that separates the shells from the nibs.
Remaining shells are online monitored and quantified for both trays. In parallel, analog hand sampling (hand 2, hand 3) was performed and via hand separation gravimetrically analysed.

In both cases 3 x samples were taken and gravimetrically analysed. The hand sampling show a standard deviation of 0,1. In total 3 x samples at 3 different month (April, June, July) was taken from tray 2 and tray 3, gravimetrically analysed and compared with the results from the **Quality Yield Cockpit (QYC)**.
The QCY-System value in tray 2 and tray 3 are within the hand sampling standard deviation and does not show a significant difference to the traditional shell counting.

Therefore the conclusion can be made, that the **Quality Yield Cockpit** can be seen as minimum as good as the analog hand sampling.

However, please note that the human factor, sampling by different people, are not taken into account. Sampling and counting was done with the same person for all trials.
Certainly, when taking this factor into account in addition to the permanent statistical analysis of the QYC the digital solution is more robust than an analog sampling every 7 hours.

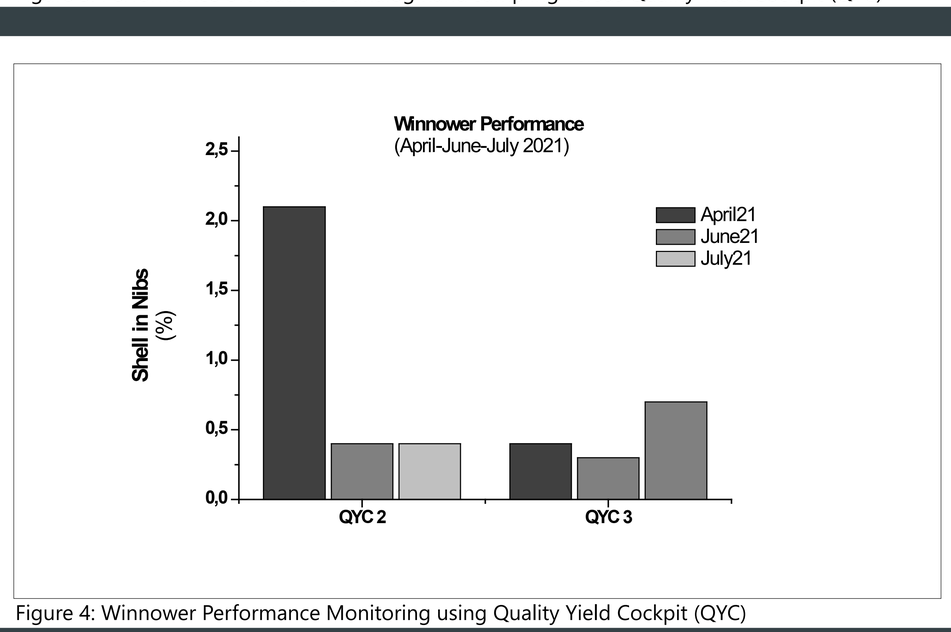

Figure 4: Winnower Performance Monitoring using Quality Yield Cockpit (QYC)

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Winnower performance of the month April 21, June 21 and July 21 without winnower adjustment is shown in figure 4.
The month April 21 contains the highest shell content at tray 2 (QYC 2) compared to June 21 and July 21. Whereas the month June 21 and July 21 show equal shell content at tray 2.

The fluctuation on tray 3 is less dominant than ins tray 2 and show a lower shell content level than in tray 2. Furthermore, the highest shell content with 0,7% is seen on July 21 whereas April 21 with 0,4% and June 21 with 0,3% is the lowest on tray 3.
All three month April 21, June 21 and July 21 passed the liquor quality checks in regards to taste, swimming particles and silicate contend.

Regarding yield management the April 21 is most interesting since the quality is within the specification by showing the highest shell content. Since 80% of the cocoa nib mass flow is passing on tray 2 and tray 3, the high shell content in April 21 should have the highest yield as seen in table 1.

Factory statement linkt to cocoa bean sourcing			
		Cocoa Bean € / T	2.500 €
		Production T / a	20.000
		Cost Cocoa Cost per year	50.000.000 €
		Liquor per Year (linked to yield)	**Delta loss per Year** (linked to yield)
Yield April 21	82,5%	41.250.000 €	0 €
Yield June 21	81,0%	40.500.000 €	750.000 €
Yield July 21	81,5%	40.750.000 €	500.000 €

Table 1 is displaying the effect on yield by adjusting the winnower performance linked to the expected quality by maximizing the yield. The average cost per tonne cocoa beans is with 2.500 €/ tonne annotated. Furthermore, the production capacity of the facility is described with a yearly capacity of 20.000 tonne cocoa per year. The cost of cocoa beans is calculated and used in order to exemplary show the impact on winnower yield management in order to illustrate the importance of online winnower monitoring referred to the yield management.
In April 21 the highest cocoa liquor yield production that correlates with the higher shell content at tray 2 shown in figure 4. Since the produced cocoa liquor in April 21 is within the quality specification, this production yield is used as a reference value and used for a yearly facility performance calculation linked to the sourcing cost.
Furthermore, the yearly facility performance linked to the yield on the month June 21 and July 21 is calculated, too. Target is to demonstrate the cost benefit by managing the yield at the winnower processing step.
Comparing the yield impact on yearly production, June 21 would have generated around 750k€ losses and July 21 of around 500k€ compared to the month April 21.

This figures show that the winnower process is underexposed when the performance is monitored only one time per shift. Raw material changes in regard to bean count, fermentation index, shell thickness and humidity can change within the unexposed winnower survey and can cause significant performance losses regarding the yield. Recipe management linked to such bean lot changes and/or new bean blends is required since those changes impacts on the winnower performance, too.