THE DIGITALLAB – TOOLS FOR CORRUGATED

ARTIFICIAL INTELLIGENCE AND ALGORITHMS CAN HELP US TO UNDERSTAND AN INDUSTRIAL PROCESS OR EVALUATE IF WHAT WE MAKE IS WITHIN THE SPECIFIED TARGETS OR NOT. ALGORITHMS CAN HELP US, AS LONG AS WE DON'T USE QUESTIONABLE SOURCE DATA.

To best explain how algorithms can help, I would like to use the example of measuring corrugated board properties.

For measuring board grammage, the industry uses a special sample cutter, as shown here. The sample cutter cuts a circular board sample. It is assumed the area of this sample is the size indicated on the device; but is it?

Circular Sample Cutter

Next, the weight of the cut sample is measured using a scale. The grammage is derived by dividing the weight of the sample by the area indicated on the device, resulting in a value in gsm.

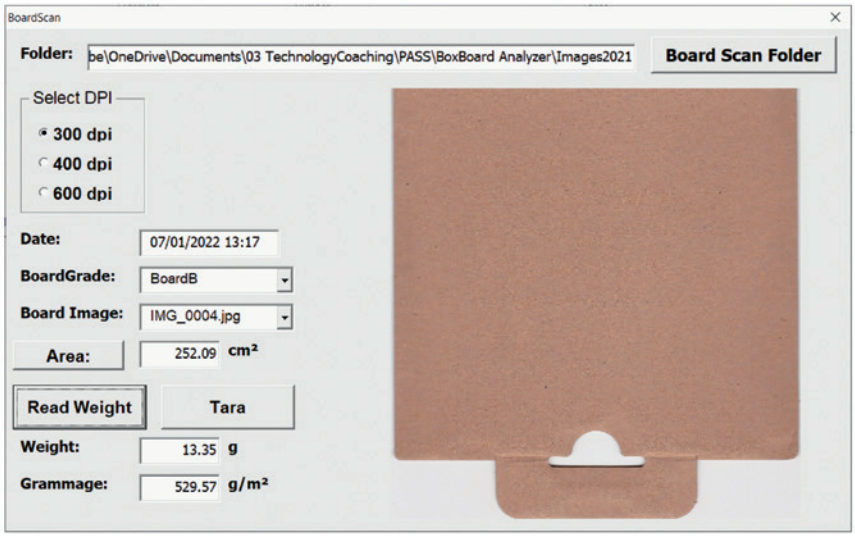
This is how it is done today, but can it be done differently – and are there advantages? The other question is the relation between the actual area of the cut sample and the value indicated on the device (which can be affected after changing knives on the device).

Could we use a standard office Guillotine for cutting the sample? The area of the sample can now be any shape.

What we need to do next is accurately measure the sample area. This can be done by using a standard flatbed scanner and scan an image of the sample. The scanned image can now be used to measure the sample area if we apply an algorithm. Once the algorithm has derived the sample area, you put the scanned board sample on a scale and measure the weight. Weight and area can be divided and the result is the board or paper gsm.

To do this, an Excel spreadsheet was designed. Yes… you can do evaluations of a scanned image in Excel. It was just finding a way to evaluate the individual pixels in an image. It is possible to import the data of one single image pixel in a cell of an excel spreadsheet. The computing is slow, but you get a good insight of what is happening.

Overleaf is a screen shot of the UserForm showing the sample scanned and the evaluated results.



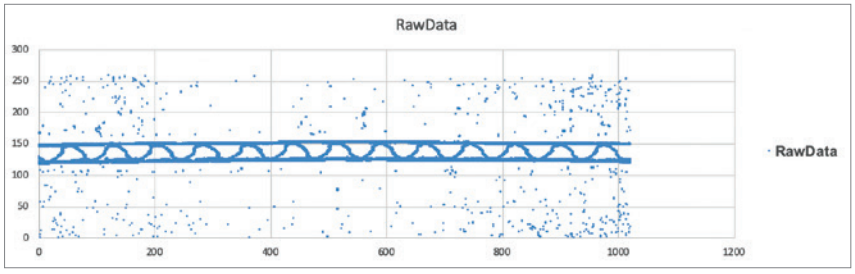
Testing the board area algorithm showed a good relation between different samples cut form the same board and the resulting measured grammage. Also, here is a tolerance and yes... the resolution and accuracy will increase when the sample size is lager and/or the scanner resolution is higher. The selected 300dpi for the scanner allows you to scan within 6 secs the sample. Excel needs a long calculation time for the sample area, but this can be resolved by using a more efficient programming language.

The proof of concept test was successful. But is this enough to change the current working procedure using a circular sample cutter? The applied measuring systems will provide feedback about the actual sample size and allows comparing ii with the by the sample cutter claimed sample size.

What else do we want to know from a corrugated board sample that one could measure using the scanner and image analysis technology? The next experiment was to make a scan of the board edge that shows the flute. It was not as simple as scanning a sample for measuring grammage, but after making an adaptor for the flatbed scanner, it was possible to scan the board edge as shown in the next image which is the actual flatbed scanned image.

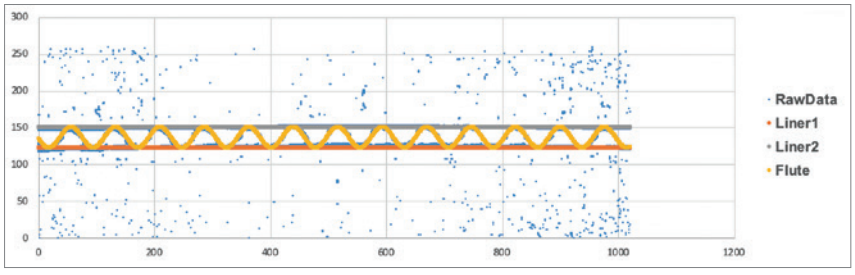
It was a bit more complicated to write an algorithm that finds

the pixels representing the board edge and put them in a graph/chart. The next graph shows the result of the earlier board edge image after applying the algorithm.



In the graph you see some noise dots, but also clearly the dots representing the board edge. The graph is flipped over the X axis relative to the board edge image. This is because an Image file starts from the top left of the image providing pixel data and the graph plots this data from the bottom left.

The only thing needed now is to write algorithms that can find the liners and the fluting. The next graph shows the raw data and the lines for the liners and flutings the algorithms came up with.



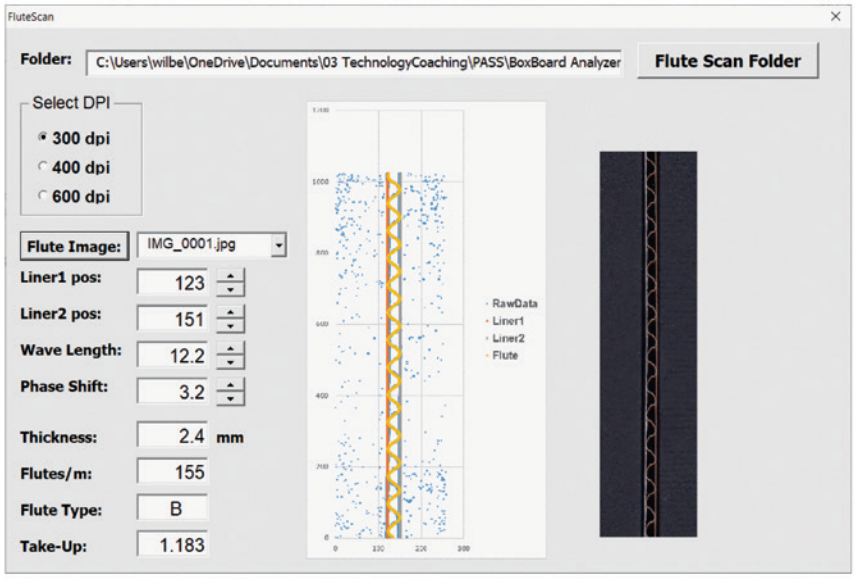
The liners are represented by straight lines and the fluting by a sinewave. That is correct, because that was the instructions given in the algorithms to search for.

From the algorithm-provided data, it is now possible to calculate:

- Board thickness;
- Flutes per meter;
- Fluting take-up factor.

The screen shot opposite shows the UserForm designed in Excel used for the board edge evaluation.

It takes about 30 secs in Excel to do the board edge evaluation. The evaluated board sample can still be used for measuring ECT as the evaluation using a scanner is non-destructive to the sample. So using this way of board evaluation allows a better correlation between ECT value and for example, the flute take-up factor.



The second proof of concept test evaluating the board edge was also successful. Both tests show that there is good and positive use for algorithms when evaluating a corrugated board sample.

You might want to do this yourself, so this is what was used:

1. Tool for cutting board samples (standard office Guillotine);
2. Flatbed scanner;
3. Scale with a measuring resolution of 0.01g;
4. RS232 USB serial connection for connecting the scale to the computer;
5. Special adaptor for scanning board edge on the flatbed scanner;
6. The Board Analyser Excel spreadsheet with imbedded image analysis algorithms.

We are planning to write a dedicate application that does all this fast and easy. Just contact if you want to know more! ■

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