

Measurement and control of important parameters in carpet finishing *

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Those engaged in the process of finishing tufted or woven carpets are constantly besieged with problems of rationalisation while having to maintain, or in most cases, to increase the quality standards.

Globalisation of the markets along with efficient logistics in the acquisition of resources, and distribution of finished products – aided by a progressive dismantling of trade barriers – allow production capacity to flourish wherever standards in terms of price and/or quality can best be met.

This background accounts in no small way for the success in the carpet-finishing sector of suitable monitoring and control systems, items of fundamental importance to the optimisation of various processes and reproducibility of their parameters.

This lecture will attempt to show the possibilities currently available for monitoring the most important quality related parameters in carpet finishing and concentrate on carpet coating.

Correcting skew and bow weft distortions

The coating process begins with the arrival of the uncoated carpet, which is distorted to a greater or lesser degree. Thus, before stabilizing by back coating, the carpet must be straightened or aligned. For this purpose Mahlo provides the Automatic Weft Straightener ORTHOMAT. Hundreds of units of different generations are successfully used in the carpet industry since decades. The actual weft straightener generation is called ORTHOMAT, Type GRFMC-10A.



Fig.1 Orthomat, GRFMC-10A

The core piece of the unit is the very sensitive distortion scanning system.

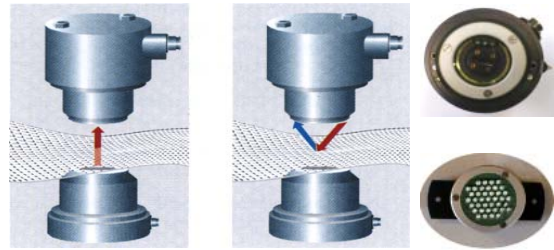


Fig.2 Weft scanner and LED projector

A number of scanners and projectors are spaced evenly across the carpet width. The carpet runs between sensors and lamps and the weft or tufting holes modulate the intensity of the light measured by the scanners. The light/dark pattern created by the bypassing carpet generates a modulated signal. An oscillating lens detects the modulated signal, which will be at its maximum whenever the lens is parallel to the weft or tufting rows.

As most of the carpets barely allow light to shine through them, better results can be obtained using reflected rather than transmitted light. The scanners therefore feature a built-in infrared light source, which can be switched on in place of the standard projectors.

The measured bow and skew distortions are then displayed by a robust, high-performance industrial 15,4" TFT touch screen and used to calculate the necessary control outputs. The movement of the two skew and two bow rollers to the necessary positions is effected with a step less hydraulic system in direct proportion to the distortion detected by the electronics. The use of an infinitely variable hydraulic system makes very fast reaction times possible.

As most of you will be more or less familiar with the basics of our ORTHOMAT, I just like to highlight briefly in the following the new features of the latest straightener generation GRFMC-10A.

- 1) A digital signal processor (microprocessor) in each scanner, to filter the signal electronically and digitally, allows much better detection results with better resolution.
- 2) Visualisation and operation via intuitive 15" TFT touch screen improves the overall user friendliness.

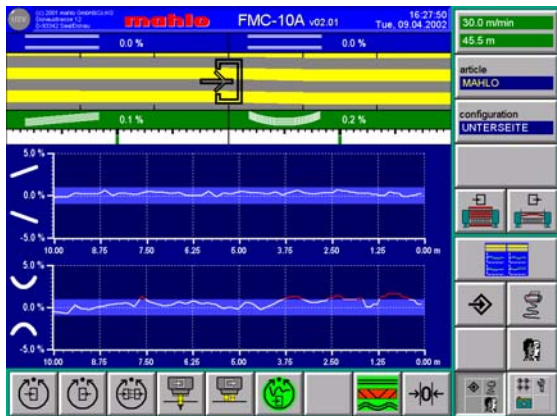


Fig.3 RFMC-10A Display

- 3) Single signal display for each scanner individually simplifies online setting.

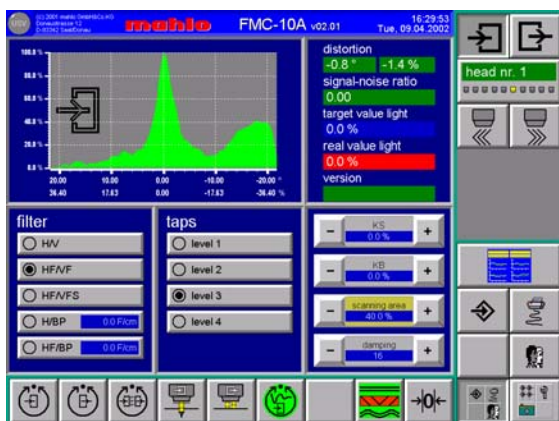


Fig.4 RFMC-10A Display

- 4) Recipe management system for memory of machine settings.
- 5) Remote diagnostic system for remote detection of malfunctions via modem or Internet.
- 6) Internal and external Ethernet communications allows extremely fast data transfer.

Mechanical appliances for correcting distortions are, in fact, available on most coating machines. But in many cases this equipment is ineffective due to inconsistent and inattentive operation.

The best solution is to exchange this mechanical straightener by a compact and sensitive scanning system optimally matched to each other.

For reduced requirements it is also possible to upgrade existing mechanical straighteners with a Mahlo weft detection and control system, type FMC-10A.

Detection and correction of distorted pattern on printed carpet

If it is not possible, for organisational reasons, to print on properly straightened carpet, there is no alternative but to straighten to the pattern.

For this purpose Mahlo has developed the Pattern Control System, type PCS-10Plus. It is able to detect bowed and skewed patterns, record all data and control for instance a Mahlo mechanical weft straightener.

The system is designed in modular way and the basic assembly comprises:

- 1) An image-recording module with high resolution line camera.
- 2) A light module.
- 3) Visualisation and user-interface including special evaluation software.

In the following we like to describe the basic function of the system:

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The light module is necessary for optimum illumination of the carpet web and it is installed directly above the carpet web. The uniform amount of light it provides right across the on-line fabric guarantees excellent, pattern related images.

One or a certain number (determined by the necessary resolution and web width) of line cameras shoot the picture of the bypassing web.

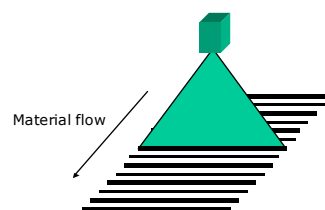


Fig.5 Line camera

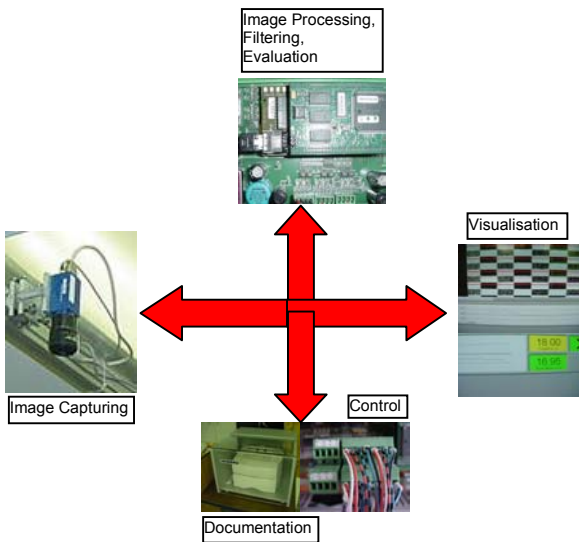


Fig.6 Principle PCS-10Plus

The digitalized image information is transferred into the memory of the capable industrial PC. The PCS-software selects within the picture a pattern part as a reference. Then the software proceeds to look for all other patterned areas resembling the first one across the total width of the carpet. The software will find any repetitive pattern across the carpet width and calculate any skew or bow distortion of the pattern. This information is used to calculate the necessary control outputs to position the skew and bow rollers of a connected weft straightener in order to realign the printed carpet pattern.

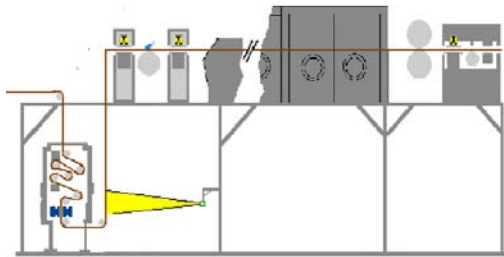


Fig.7 Straightening with PCS-10Plus

To enable the system to detect pattern distortion it requires a repetitive pattern across the carpet, which repeats itself every few running meters.

In case there is only a linear structure across the carpet, a special software algorithm called line analysis can be used to track cross web lines and to establish the degree of bow and skew from the resultant contour.

A further highlight is the "Teach-in" function, which can detect a pattern extending from one selvage to the other. Without any manual intervention whatsoever, the system "learns" the location of well-defined, patterned area,

how they are arranged in relation to each other, and memorizes the associated bow and skew configuration. Should the pattern recur, the system will find the stored patterns again, and compare the one in relation to those memorized.

Online measurement and record of pattern repeat length and width

In the final inspection stage of the carpet manufacturing, normally at the exit end of the coating line, each separate roll of carpet has to be measured for lengthwise and crosswise repeat and finished width. The reading need to be recorded which still happens mostly manually.

In many cases such data can only be obtained by stopping the inspection line in order to take the measurements and still only random checks can be done.

To overcome this problem the earlier described Pattern Control System can be used also for this purpose.

The same hardware (image recording module, light module) combined with a different software for pattern repeat measurement can automatically and continuously monitor online on the bypassing carpet web the repeat length and repeat width.

Again a well-defined part of the pattern is used as reference. The Pattern Repeat Software proceeds to look for all the other patterned areas resembling. After the same pattern part was found several times in length and cross direction the system can calculate both length and crosswise design repeat, continuously, automatically and with unflinching accuracy from start to finish of the entire batch of carpeting.

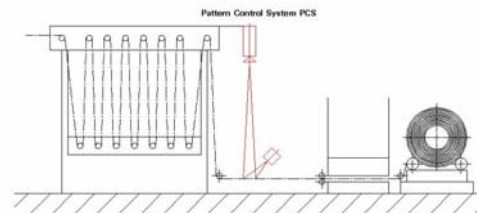


Fig.8 Inspection area at coating line outlet

It also can print out a full record of the various readouts and the information it contains can be of invaluable assistance when it comes to laying the carpet, because it allows the rolls to be sequenced to minimized pattern variations during the installing process. Rejects because of varying repeat length and repeat width from roll to roll can be avoided.



Fig.9 PCS-10Plus installation

Some of our customers installed in the inspection area even two PCS systems: one for pattern distortion detection, one for pattern repeat length and width.

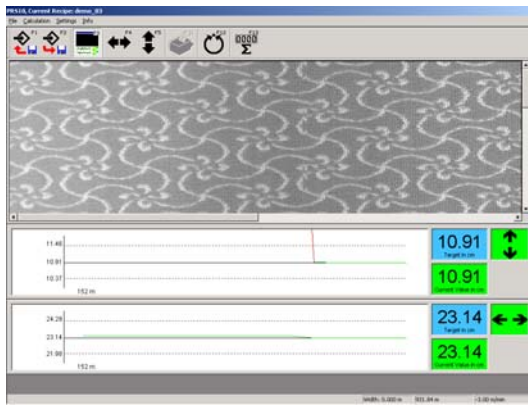


Fig.10 PCS-10Plus

Area weight measurement before and after coating

The perfectly straightened uncoated carpet is now presented to the coating machine. First of all, the preliminary coat is applied. Spot checks are necessary at frequent intervals to determine the weight of the substance applied, achieved by cutting samples from the carpet and weighing them. This destroys large amount of material and only random checks are possible.

Without online weight measurement fluctuations cannot be avoided for whatever reason. Therefore in most cases more coating material than really necessary to be on the safe side is added. The same applies to the following foam coating process. For contact-free measurement of the weight of applied substances on on-line goods measuring instruments are used to determine the weight on running material.

The carpet weight is determined via the gravimetric principle. Beta rays attenuate in proportion to the weight of the material through which they are passed. The current in an ionisation chamber, on the opposite side of the carpet, is a measure of the material in the cross sectional area being scanned and with appropriate calibration, for the area weight on the on-line carpet as well. The isotope normally used for carpet is Strontium 90.

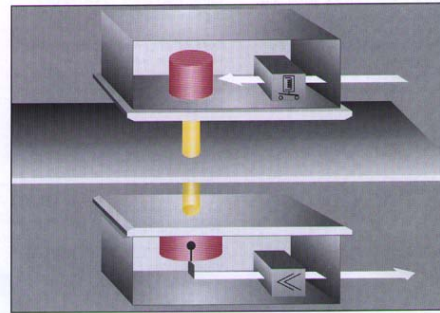


Fig.11 Measurement Principle

For this purpose Mahlo can offer the modular Quality Control System Qualiscan, type QMS-10A. A Qualiscan can accommodate up to four weight scanners either integrated in traverse assemblies or installed at fixed positions across the carpet width.

The weight sensors in the traverse assembly run to and fro across the carpet and provide a cross sheet profile of the measurements taken from edge to edge.

The use of up to four scanners allows to measure raw weight before coating, weight of pre-coated carpet, weight of dried carpet, weight of foam coated carpet within one system. Via calculating the differences the weight of coating can be calculated, displayed and controlled.

It goes without saying that the system is equipped with a so-called same spot measurement (necessary especially for high-low qualities and short batches) and automatic self-calibration. With the automatic control of the coating process integrated in the software it is possible to achieve the closest weight tolerances and save a lot of coating material and therefore cost.

The Qualiscan basically consists of:

- 1) Basic terminal with 15" TFT touch-screen for control and visualisation, based on Windows NT with self-configurable displays of the relevant parameters as profile, trend and bar-graphics.

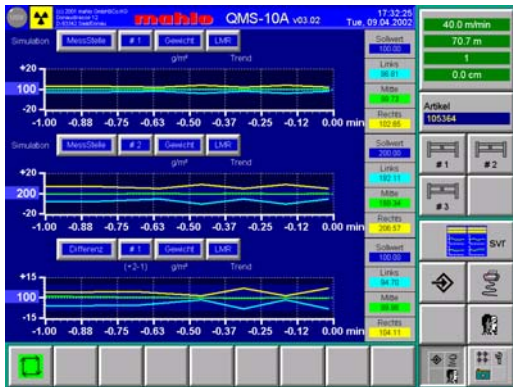
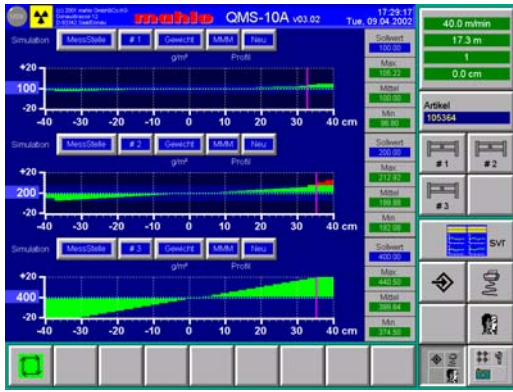


Fig.12 QMS-10A Display

2) Intelligent weight sensors, microprocessor based with interface for data transfer to the basic terminal via Ethernet (TCP/IP) connections.



Fig.13 Intelligent stationary weight sensors

3) Traverse assemblies in standard and in compact executions, designed for highest accuracy requirements.



Fig.14 Standard traverse assembly



Fig.15 Compact traverse assembly

4) Printer package including software for printout of process related protocols

By employing a QMS-10A within a carpet coating line following benefits can be achieved:

- Tighter weight tolerances
- Elimination of safety margins
- Lower target settings
- Less waste material
- Less rejects
- Economic use of raw material
- Consistent end product

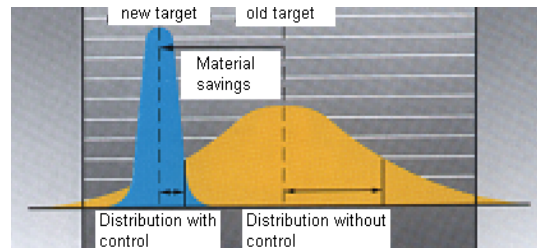


Fig.16 Savings

Besides the already described systems Mahlo also can offer equipment for

- Dwell time measurement and control
- Exhaust humidity measurement and control
- and
- Moisture measurement and control

Because of shortage of time a detailed description is not possible during this lecture.

With all the before described or mentioned measuring and control systems, Mahlo offers the carpet manufacturer reliable tools to help promote a quality product and economical use of resources (personnel, capital and energy) by optimising processing. In the final analysis, they contribute towards a spectacular reduction in cost and an increase in returns, and hence towards a long-term strengthening of the user's ability to compete in a global market.