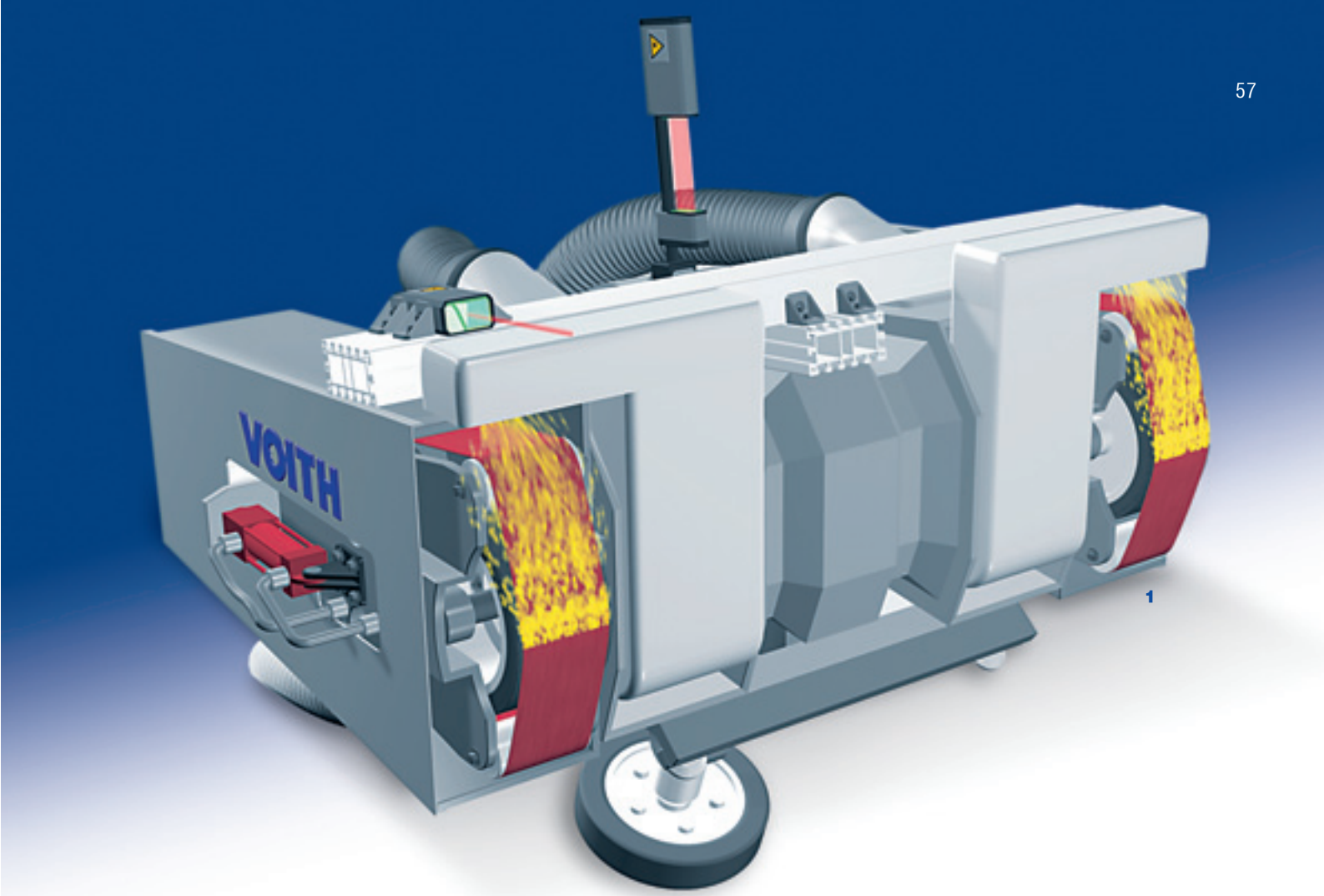

Virtual Reference Grinding –
An innovative method to re-condition the Yankee Dryer in a Tissue Machine

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The Yankee dryer in a tissue machine is an unique, multi-functional component. It is backing the press rolls, it is a sheet carrier, a large drying cylinder and a creping surface all in one. The Yankee is the central, most critical and most expensive part in any conventional tissue machine.

The condition of the Yankee dryer, and in particular the Yankee surface, is critical to the operational performance of the tissue machine.

Re-grinding the Yankee dryer, to re-condition the surface and re-establish the dryer crown, has become a routine maintenance operation carried out by specialists, usually at intervals between 12 and 36 months, depending on the operating conditions. Any necessary maintenance of the Yankee results in machine downtime, as it can only be performed 'on-site' and 'in-machine'. Similarly, regrinding of the Yankee normally requires a major shut-down of the tissue machine.

In co-operation with the German Fraunhofer Institute, the Voith Paper Cylinder Service group has developed an innovative technology named "Virtual Reference Grinding", abbreviated to "VRG", to re-grind the Yankee dryer. VRG is a very small, but powerful dual head grinder, which is mounted directly onto the existing creping or skinning doctor holder. To install this grinder, almost no paper machine components need to be disassembled **(Figs. 1 and 2)**.

Fig. 1: *VRG system.*

Fig. 2: *Installed grinder.*

Fig. 3: *Helix surface measurement.*

Fig. 4: *Measurement system.*

Fig. 5: *2-D carpet-view of cylinder surface.*

Fig. 6: *3-D surface representation.*

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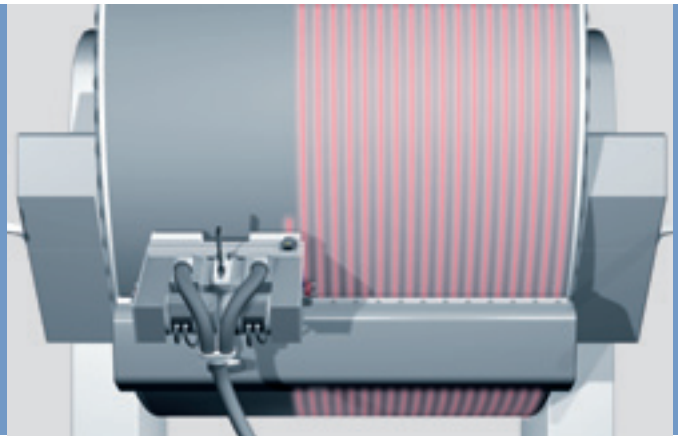

VRG technology uses, as a reference, a spring steel wire spanned equidistant to the main axis of the dryer, and incorporates on-board laser systems to continuously measure both the distance to the Yankee surface and to the reference wire. Indexing sensors and electronic level sensors continuously record the position of the measurement unit, which is freely moving on the doctor holder, in relation to the dryer **(Fig. 4)**.

The Yankee surface is measured in a helix, collecting up to 1,000,000 data points from each sensor, simultaneously **(Fig. 3)**.

The surface description, in helix format, is mathematically processed into a grid matrix system, taking into account and correcting all movements of the measurement/grinding unit. The grid density can be as small as 10 x 10 mm, very accurately displaying the topography of the entire dryer surface. Typical measurement accuracy is within a band width of 20-30 µm.

The system can display the Yankee surface in 2-dimensional carpet-view, or in real-time 3-D visualisations, which allow for in depth investigations into dryer wear patterns and their correlation to production related problems. A standalone visualisation software package provides further valuable information for ongoing optimisation of the Yankee within the overall production process **(Figs. 5 and 6)**.

Any conventional grinding technology uses a geometrical reference plane. This can either be the grinding bed itself, or any straight plane (reference point) incorporated into the grinder. The shape of this so called reference is copied or transferred onto the roll or cylinder to be ground, often (as required) in the shape of a 'crown-profile', or camber. In order to maintain accuracy on these geometrically functioning grinders, the grinding

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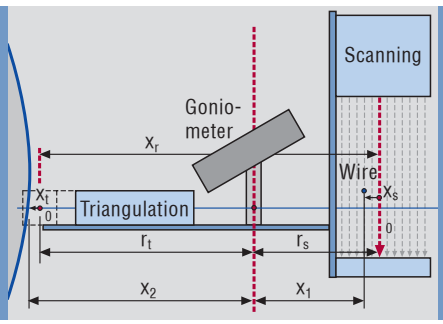

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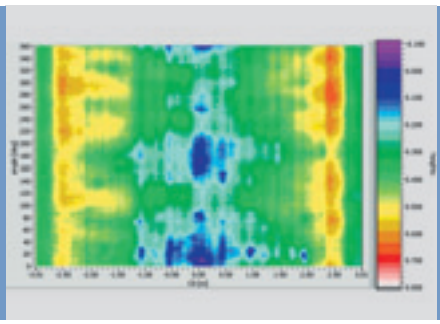

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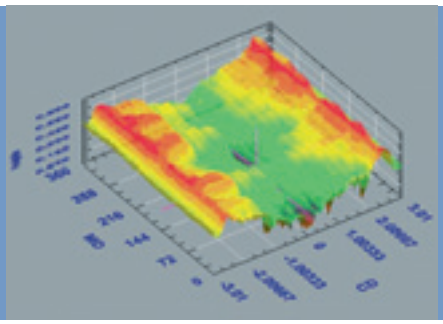

Fig. 7: *Grinding head.*

Fig. 8: *Force controlling the grinding process.*

Fig. 9: *2-D carpet-view of a finished cylinder.*

Fig. 10: *Centerline run-out (TIR) achieved.*

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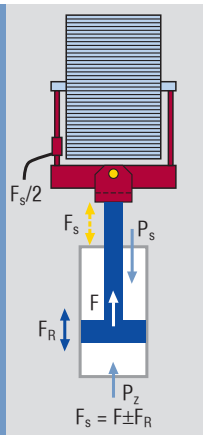

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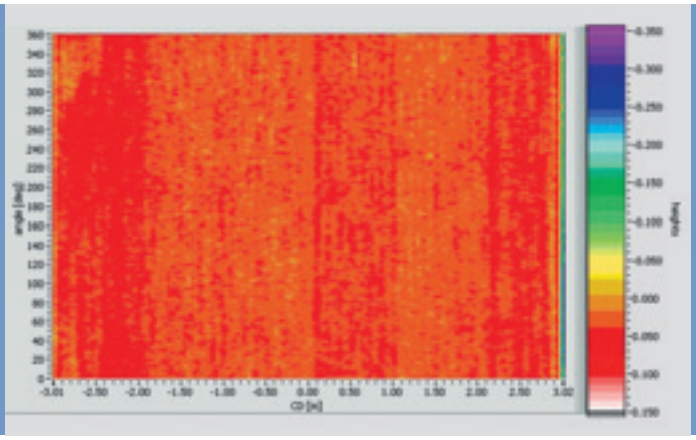

bed needs to be very accurately machined and must be sturdy and heavy, to maintain form stability.

VRG grinding technology is unique and fundamentally different. Grinding is not accomplished through a geometrical coupling between the grinder and the roll or dryer, but through a force-coupling. Material will be removed only where necessary **(Fig. 8)**.

Following collection of the surface topography data, the grinding cycle uses the surface description in the form of an electronic grinding protocol to control the forces applied to the grinding wheels, and thus the abrasive powers. This is accomplished using very fast acting hydraulics, whilst the actual applied grinding forces are further measured continuously. Grinding forces up to 1000 N are applied within a reaction time of less than 20 milliseconds. During the grinding process the control computer simulates, in the background, material removal and the expected form and shape of the dryer, in real-time, to prevent over-cutting of the surface.

Only the required grinding forces in relation to the out-of-profile condition of the dryer are applied and controlled. The grinding equipment can, therefore, be extremely light-weight, and its actual movement accuracy is not important.

With VRG technology, Yankees can be reconditioned in a fraction of time when compared to conventional grinding technology. Usually, no ancillary machine components need to be removed for the grinder installation. Down time and other mill cost savings are, therefore, considerable.

VRG is now proven as an extremely powerful machine tool capable of taking the guesswork out of the reconditioning of Yankee and MG cylinders, and can be summarised as follows:

- Compact, lightweight equipment that can be easily shipped/air freighted.
- No need to disassemble paper machine components to facilitate installation of VRG grinding unit.
- Reduced installation, set-up and equipment removal times.
- Cylinder re-grinding can be performed much faster and more accurately that any previously available grinding technology.
- Due to VRG system accuracy, only the absolute minimum of material is removed to achieve Yankee profile, thereby ensuring optimum asset preservation **(Figs. 9 and 10)**.
- 3-D data acquisition via system computer creates a comprehensive picture of entire Yankee surface providing a valuable database for on-going tracking of Yankee condition and performance.

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