Is the present description of paper properties sufficient for paper converting?

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Papermaking is characterised by a great variety of options: different pulps, pigments and additives are used on specifically designed machines to manufacture products with customized properties. Every papermaker who has ever had to transfer a production from one machine to another knows that the raw materials and manufacturing equipment used manifest themselves in the property profile of the resulting paper.

Figure 1: Papermaking must satisfy many converting demands

Converting processes have a multitude of special features as well: each of them has its individual fingerprint, depending on the printing machine and inks, adhesives and equipment configurations used. And, converting is anything but linear: the order of printing, cutting and gluing operations, for example, can vary greatly, and the print method-substrate combinations traditionally used in specific market segments are changing or being replaced. Paper substrates must therefore be all-rounders that are equally suitable for offset and inkjet printing, cold and heat bonding, pre- and post-print corrugating etc.

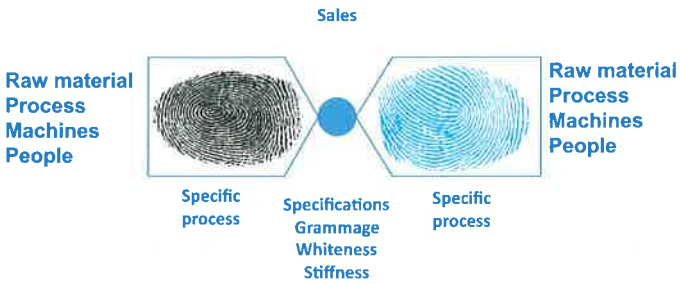

Figure 2: Individual characteristics of papermaking and converting

In sales and marketing, the transfer point between papermaking and converting, the description of paper properties is usually reduced to a minimum. Specifications are limited to basic properties, and there are very few regulations on the data to be provided. Experience has shown, however, that paper converters need more information on MD and CD profiles, surface characterization and runability to avoid quality problems. This leads to ever more complex qualification processes and makes it increasingly difficult to agree on the information to be supplied in the case of recipe deviations.

The value chain is increasingly under pressure: manufacturers can minimise but not eliminate fluctuations in their processes, and the raw materials provided by suppliers are not constant either: changes in deliveries, recipes and legal requirements are a constant source of variation. On the other hand, it makes no sense – neither organisationally nor technologically – to respond to every little change by adjusting the product qualifications.

To cover all quality deviations caused by fluctuations and unwanted recipe changes, specifications are kept rather vague vague in the industry. Moreover, stipulating the recipes or recipe combinations by contract would make it impossible to continuously optimise them. In particular the complex chemical processes involved cannot be fixed in their entirety. Upstream suppliers do not specify which dispersants, biocides or defoamers they use, and pulp producers can use different modifications of the same tree species which results in different fibre properties. Another aspect is that during shift work in a paper mill, there is simply not enough time to describe all parameters relevant to the many converting processes possibly used afterwards. Furthermore, the industry has a broad range of mechanical and optical test methods, but only a few chemical-physical and process-technological tests. Many of them are very complicated and time-consuming, require the conditioning of samples and can therefore not be used for quality assessment in shift work schemes.

Yet another problem is the measuring technology itself. Many of the test methods are between fifty and one hundred years old and no longer suitable for the processing speeds and methods commonly used in the industry today. The Cobb water absorption test, for example, was originally developed to test the writing properties with inks and pens. Other techniques like gloss or smoothness measurements lead to results that are not comparable due to the different physical approaches used.

The dilemma is aggravated even further by changes in the value chain: large paper machines and expensive grade changes make it necessary to produce large quantities to save production costs, whereas converters want ever more flexible suppliers capable of providing small lots, specific formats and customized services at optimal speed.

During paper production, the machine operator often does not know which customer gets which paper quality based on which order. In particular when testing unspecified product properties, they cannot allocate the test result to a specific customer. Quality deviations are thus not detected by mill workers but by the customers, who then complain about poor runability and services. Printing press operators often say that they must use papers which are known for their poor runability but still purchased because of the low price.

WHICH SOLUTIONS ARE AVAILABLE IN THE MARKET? The aim is to control paper machines in such a way that their manufacturing quality varies less, i.e. complies with closer tolerance limits. To ensure the consistency of formulations, raw material suppliers must be bound by contract to guarantee relevant properties. This must go far beyond typical parameters like grain size, fibre length and viscosity: The complete spectrum of additives used must be specified as well because they have significant effects on paper quality.

For a sufficient solution, more research is necessary. For example a research to assess the migration of additives to paper surfaces is started. The migration behaviour of some additives could already be clarified. It could be demonstrated, for example, that certain AKD's migrate and render the paper surface hydrophobic after two weeks. The effects of other additives have yet to be investigated: In inkjet and HP Indigo printing, surfactants were found to have adverse effects on the print quality, whereas minor migration problems were encountered in offset printing.

Conventional measuring techniques cannot describe the quality characteristics of paper with the accuracy needed today. In industry, it is common practice to use large measuring surfaces to average quality parameters like Cobb number or smoothness or detect specific inhomogeneities (mottling). Scientific techniques like light microscopy or SEM, by contrast, analyse very small areas and cannot be transferred to large-size industrial measuring applications with reasonable outlay.

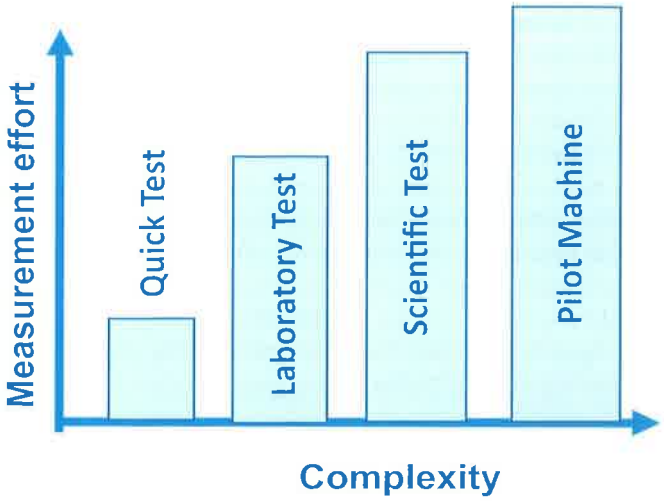

Figure 3: Scope and complexity of measurements

Simple, easy-to-use test methods for quality parameters relevant to converting are desperately needed in the industry. Many companies have developed their own in-house methods to solve specific quality problems, but most of these quick tests do not bear close scientific scrutiny and can therefore not be used for reliable quality assessments. Scientific methods, on the other hand, are too time-consuming to be widely applicable in industry.

However, there are positive developments as well:
Some examples are to establish an industry-wide standard by introducing qualified test methods or even certification procedures. Some of the methods already developed are not related to specific production batches. If used in the form of multiple monitoring schemes, they can be regarded as a good general production standard. PTS has developed certification procedures for food contact papers according to BfR 36, ingredients and pulps that are related to the process rather than single production batches, i.e. the certificates confirm a consistent product quality across all batches.
Another approach is the development of a multi-variable control system to optimise the quality consistency of its paper machines. The highly complex control mechanism improves the formation via a constant water line. The basic setting of the digital system activates a number of closed control loops and algorithms to control the entire stock preparation system by means of a few process parameters. Because formation problems are a major cause of inhomogeneities in paper, the formation control system is expected to result in a much more consistent product quality.
The next option is an optimisation programme that ensures a more reliable production window and smaller variation range: the coating process is stabilised, which leads to a more consistent product quality.
To reduce the variation of wastepaper quality, a concept to better monitor and control quality fluctuations in paper for recycling was developed. Sensors of a new generation and a novel approach to quality evaluation make it possible to increase the quality consistency already via the raw material input. The more controllable furnish quality is expected to make up for the higher outlay for quality evaluation.
Digital control systems need to process data to a format which can be used as a common language by all systems involved. In this way, they can ensure the product quality and repeatability even in case of varying raw materials and highly complex production systems. These systems cannot be developed and installed by single companies or as local innovations – digital solutions must be integrated in all processes of the value chain. Economic success through reliable planning and the full use of plant capacity can only be achieved by looking at the productivity of all processes involved.

ARE WE DOING ENOUGH TO REALISE THE VISION OF PAPER INDUSTRY 4.0? A joint language to evaluate the product quality ahead of value creation is the basis of innovation. So far, the partners of the value chain have only managed to agree on a very limited and basic joint language. We need product qualifications that are adequate for the higher complexity and requirements to paper substrates. They must be comprehensible, easy to use and clearly practice-oriented. To function as link between quick tests and scientific examinations, they must be based on the same models and provide transferable results.

To date, neither paper producers nor converters have been able to develop a joint platform to solve these issues. Every sector and market segment watches carefully over its standards and developments. Only very few people have started to – hesitantly – use the same quality language along the value chain. Even in project and research groups, exchanges are limited by competition and codes of conduct.

COOPERATION IN THE VALUE CHAIN IS THE BASIS OF A JOINT LANGUAGE. The development of a joint coding technology shows how the companies of a sector can successfully cooperate. In the last ten years, the packaging sector has developed serial codes for pharmaceutical packaging that make it possible to fully trace each individual box. This is demanded by new European regulations which will become binding for German companies when the country's regulation 2016/161 comes into effect in 2017. Similar new regulations are being prepared or have already been implemented in France, US, Turkey and China.

The joint work of FFPI, the German research group folding boxes for the pharmaceutical industry, PTS and several printing unit, packaging varnish and instrument manufacturers has led to a practical standard for packaging coding that complies with regulation 2016/161. It can serve as a platform to link packaging, printing and digitalisation in a way that benefits customers. Economically successful solutions can only be found by including all partners of the value chain – manufacturers, suppliers, packers and brand owners.

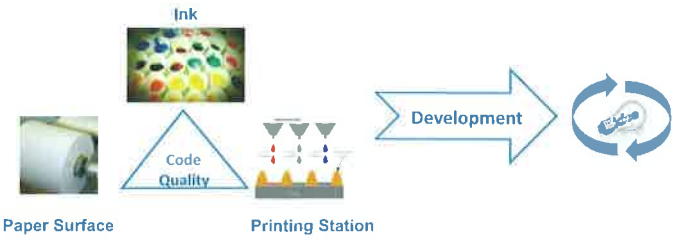

Figure 4: Cooperation of the value chain in the field of packaging coding

The standard has recently been tested in a round robin of over 25 measuring devices and test laboratories. The results have shown how differently the laboratories are still working. A lot of work has yet to be done: The standards and procedures must be further optimised to successfully implement them. They must be widely used to evaluate the legal conformity of codes, which means establishing them in the entire value chain ranging from paper production to pharmaceuticals.

All these issues need to be addressed. For example, this year's printing and imaging symposium will provide an open discussion platform to contribute to the needs of the market. ↙

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