



Covey Consulting News

*Serving the industry for 20 years:
1989-2009*

June 2009

In this edition,

- Speed, efficiency & profitability is discussed here by Dennis Shore
- Qualitative chemical analysis as a tool for mill troubleshooting with Steve Grist
- Feng Shui is eloquently discussed here by Geoff Covey



Dianne Jones

SIZE MATTERS – OR DOES IT? **Dennis Shore**

For most of the history of the pulp and paper industry, the median capacity of a paper machine or a pulp mill has been increasing. Conventional wisdom has it that if you could just make the operating unit a little bit bigger the unit cost of production would decrease and the return on investment would improve.

This was more or less true when demand for paper continued to grow year on year and additional capacity could be absorbed without necessarily replacing an existing unit – new capacity is always more attractive if it does not have to include the write off another manufacturing unit.

The drive for larger capacity reflected 2 important assumptions. A larger unit could generally be run with the same or not many more people than a smaller unit and thus the variable labour cost decreased. It needs to be recognised these days that unit labour costs are relatively small, even in high cost countries, so that the upside on this aspect is now relatively small in the context of the capital involved. The other aspect relates to an empirical rule of thumb that capital costs decrease at a lower rate than the increase in capacity thereby reducing the investment cost per tonne of production. For the pulp and paper industry the capacity factor empiricism using an exponent of 0.6 seems to be a pretty good approximation. Thus a doubling of capacity increases capital cost by a little over 50%.



The anticipation of these factors has driven the quest for ever wider and faster machines or larger unit sizes for pulp mills. The era of mini-mills in the USA in the 1990's seems somewhat of an aberration these days as the rules above still applied to a bigger recycled mill and "world scale" has been standard for the new Chinese containerboard mills.

The clearest example of this growth factor lies with newsprint, a grade which has remained more or less the same for many decades, basis weight aside. Annual capacity of a state of the art newsprint machine in 1909 was in the order of 5000 tpa and had increased to about 100,000 tpa by 1959. In 2009 the annual capacity for a new world class newsprint machine exceeds 400,000 tpa – an eighty fold increase in capacity in 100 years. The Metso machine at Chenming Shouguang PM 4, which started production in January 2007, is the world's largest newsprint machine with a design speed of 2,000 m/min and a wire width of 11,150 mm (trim 10,550 mm). It has a design capacity of 480,000 tpa and currently output averages above 400,000 tpa.

This rate of capacity increase is not quite at the same level as achieved in the silicon chip business where the so called Moore's Law (named after Intel co-founder Gordon E. Moore) describes a long-term trend in the capacity of integrated circuits. Since the invention of the IC (integrated circuit) in 1958, the number of transistors that can

be placed inexpensively on an IC has increased exponentially, doubling approximately every two years. The trend has continued and appears to be still holding. A similar trend applies to other computing components such as hard disk storage. We thought you would really need to know this important “law” although our every day experience will have demonstrated this fact qualitatively – think about your home PC, camera flash cards, mobile phones and so on.

Getting back to the paper business, like all industries the significant factor in pulp and paper manufacturing has been the evolution of the technology. The inference that paper making is still pretty much the same in concept now as it was when the Fourdrinier brothers patented their improvement of Nicholas Robert’s design (1798) and Bryan Donkin developed and industrialised paper manufacture, is well off the mark.

The progress in pulp and paper manufacture over its 200 year history may not be as dramatic as the development of the integrated circuit business but compares well with say the automobile. At every stage of the cycle from tree or recovered fibre to paper, and in the management of water and wastewater there has been a technical revolution that has dramatically improved productivity, efficiency and uniformity.

Changes particularly in the paper making process will illustrate this evolution. The paper machine itself is pretty much unrecognisable from the state of the art machine of 100 years ago, let alone 200 years ago. Single ply or multi-ply, the machine will use a gap former to produce the basic sheet structure. The headbox will be a complex engineering masterpiece with feedback computerised dilution and slice profiling and a controlled pulse-free highly uniform, very dilute fibre suspension. The formed sheet will essentially be transported the entire machine with restrained support and little if any free draw. The sheet will be formed between a complex woven structure made from synthetic yarn with a design to encourage wear life and drainage but to minimise marking of the sheet surface and to minimise two-sidedness. Drainage elements will be stationary rather than rotating and will be ceramic or made of durable synthetic polymers. Forming is still followed by pressing but the sheet will be both cosseted by press “felts” made from exotic polymeric materials, woven &/or needled and at the

same time subject to long and short pressing zones at intense loadings.

The “felts” have the capacity to transport and release the large volumes of water removed in the pressing operation. The modern press configuration will probably be a tandem “shoe” press but may also include long nip presses with vacuum assist. Roll cover materials will be exotic materials, although some may still be notionally “rubber”. The sheet will still undergo final stage drying over steam heated cylinders but these will be in a single tier restrained drying configuration without open nips or free draw and transported by synthetic dryer screens.

Many machines will have a size press with metered or offset application of starch or other material. The after-drying section may include infra red supplemental drying. The dried sheet is likely to have some calendaring via a single nip segment controlled roll, possibly at elevated temperatures and some form of profiling capability. The sheet will be wound up on a reeler with roll density control and utilise a tape reel turn-up device for roll changes. The sheet will be fed through the entire machine at start-up without manual intervention via a range of mechanical assist devices.

Throughout the manufacturing process the system will be controlled by an integrated “computerised” control system. This will ramp the machine to its ultimate capacity and maintain physical quality parameters within close tolerance at all times via continuous feed back from an array of specialised quality sensors, supplemented by some feed forward measurement. Drive speed and draw control will be effected via sophisticated AC drives that are digitally controlled and modified not only by quality and productivity demands but optimised to accommodate information from on line maintenance monitoring devices and in some cases energy demand strategies. Theoretically the control system is able to control everything to maximise profit via adaptive control and expert systems. High sustained speeds are possible because suitable bearings are available and supported by sophisticated lubricants that are monitored and controlled on line.

The machine roll will transport to the winder without manual assistance and roll set-up and roll starts will be automated. Ejected customer rolls will

transport on conveyors for wrapping and to the despatch area. A range of automated devices including robots will manage and complete the sequence.

The chemicals used in many cases were not commercially available or certainly not used widely until the last 20 years. Alkaline sizing and the explosion in use of calcium carbonate have significantly changed the furnish material in communications papers.

Not one of these components or processes was available 100 years ago & very few of them even 50 years ago.

The net outcome is that average operating speeds of paper Machines has risen dramatically and total efficiency of machines is also significantly higher. The trim width of machines continues to increase although at a diminishing rate. Fundamental engineering issues dictate that as width increases the diameter of rolls and the cantilevering support necessary for machine components increase disproportionately, with cost and fabrication consequences. For example roll deflection increases in proportion to the fourth power of roll width.

Speed rather than width has been the basis of much of the growth in capacity. One hundred years ago the speed capability of paper and Board machines had just exceeded 160 m/m, a massive leap from the 5 m/m achieved 200 years ago.

It is always a challenge to keep up with the fastest running machines in the world. Of course the machine makers want to announce a new record all the time whereas probably many of the paper making companies would not necessarily want to be promoting such information. Anyhow recent claims for some of the main paper categories show some pretty impressive numbers.

Voith inform us that Rhein Papier has set a new world speed record for newsprint on PM 1 at their mill in Hürth in Germany. On 10 March 2009, an average speed of 2,010 m/min was achieved over a period of 24 hours during the production of standard newsprint with a basis weight of 42.5 gsm

at around 95.2% time efficiency. Over a period of 20 hours a maximum speed of 2,015 m/min was reached.

Metso had earlier announced that a Metso supplied PM 12 at Stora Enso Kvarnsveden mill in Sweden has improved the world speed record for SC paper production. The machine reached a 24-hour record of 1,926 m/min on 21 January 2009. The top speed achieved during the period was 2,009 m/min.



Voith in late 2008 touted that Gold East Paper achieved a world speed record for woodfree papers at their mill in Dagang, China. An average speed of 1,770 m/min was achieved in the production of double-coated paper at a basis weight of 90 gsm over a period of 29 hours. The operating time efficiency was 87%.

In the world of containerboard the Metso PM 6 at Papierfabrik Palm's Wörth mill in Germany set a new daily production world record on 21-22 July, 2008 of 1,608 m/min making corrugating medium at a basis weight of 95-105 gsm. Running efficiency was 91.4% at an average production of 101.5 tons per hour.

The cartonboard speed record has seen the biggest jump with APP Ningbo's Metso supplied PM 6 achieving an average speed over 24 hours of 970 m/min in August 2008. This incidentally also achieved a world production record by producing 3,504 tpd of 350gsm art board. This is about 1.2 million tonnes per annum. Indeed the million tonne a year machine has comfortably arrived.

The Metso supplied PM 4 tissue machine at Fabrica De Papel San Francisco SA de CV, in Mexicali, Mexico set a new 24-hour world speed record for tissue production averaging 2160 m/min on 18 March 2009.

So what does all this mean? We do not know what level of profitability these new machines achieve but we do know that it is a rather dismal picture when looked at as a whole. In 2007, according to PwC the ROCE (Return on Capital Employed) for the top 100 paper companies edged up from a dismal to 4.6% to an almost as dismal 4.8%. The situation for 2008 was expectedly awful. Global

ROCE decreased to an estimated 2% with only five companies recording ROCE of 10% or greater. Twenty-six companies generated negative ROCE in 2008 compared to only eight in 2007. 2009 does not bear contemplation! But in fact low returns have been the norm for most of the last 20 years. In the decade to 2001 the USA barely achieved 5.0% ROCE. Europe has achieved about 1 percentage point higher on average - but hardly anything to cheer about.

A careful analysis will reveal that much of the reason for this situation lies with the fact that for decades the paper industry justified capital expenditure on the basis of significant earnings resulting from additional sales. The problem was that several competitors appeared to grasp the same “opportunity” with the result that the industry has suffered from chronic over capacity. It is only over the last 2 or 3 years that USA and European manufacturers have demonstrated any real commitment to retiring old capacity to make way for the newer and more efficient capacity. In fact in the USA over the last year it has been a matter of simply retiring old capacity to adjust for a significant decline in demand, not the building of new capacity. In February for example the USA consumed about half the annualised rate of newsprint that had been consumed in February 2001. The American Forests and Paper Association reports that total US capacity to produce paper and board moved down slightly in 2008 - continuing an eight year fall. US capacity last year of 87.4 million tonnes is almost seven million tonnes less than a peak of nearly 94 million tonnes in 2000. In 2008, 41 paper machines as well as 18 complete mills were shut permanently. To quote a recent headline – “Americans aren’t buying anything, let alone American”. Ironically the first new non-tissue machine to start up in the USA in the best part of a decade was the new Visy containerboard machine at Shreveport in Louisiana in April 2009. At the same time huge capacity growth in Asia has more than offset the decline in capacity in North America and Europe continues to grow capacity. On current trends China this year will surpass the USA as the largest producer of paper in the world.

While ever there is a significant overhang of capacity in the world, customers will essentially force suppliers to sell at prices approaching manufacturing cost – the characteristic of a commodity grade. The real price of paper products has been falling

relentlessly for decades and despite the poor industry financial returns this will probably be the continuing trend for the foreseeable future.

As much as manufacturers would have us believe otherwise, most major paper grades meet the definition of a commodity - a product which is interchangeable with another product of the same type, and which investors buy or sell, (usually) through future contracts. The price of the commodity is subject to supply and demand and this is very much the case for paper and pulp.

It seems the pain will continue a little longer. It is not the size of the machine that matters as much as the size of the market.

Engineering? Question:

A Backhoe weighing 8 tons is on top of a flatbed trailer, and heading east on Interstate 70 near Hays, Kansas. The extended shovel arm is made of hardened refined steel, and the approaching overpass is made of commercial-grade concrete, reinforced with 1 1/2 inch steel rebar spaced, at 6 inch intervals, in a criss-cross pattern layered at 1 foot vertical spacing.

Solve: When the shovel arm hits the overpass, how fast do you have to be going to slice the bridge in half?! (Assume no effect for headwind and no braking by the driver...)

Extra Credit: Solve for the time and distance? required for the entire rig to come to a complete stop after hitting the overpass at the speed calculated above?

Well if you can't work it out, don't worry the picture really tells the story...



Chemical Analysis – An Invaluable Tool for Mill Troubleshooting.

Steve Grist

The usefulness of chemical analysis data as a basis for solving problems in a chemical process (such as pulping and papermaking) seems like a very obvious statement. However it is an under-utilised tool because many mill staff do not have a comprehensive appreciation of the wide range of chemical analysis techniques available and what the results of these tests can offer the mill.

There are two main classes of chemical analysis; qualitative (what is it?) and quantitative (how much?). In this issue of CC News we will consider the qualitative tests, with next month's article focused on the quantitative aspects of chemical analysis

Qualitative Analysis or “What is it?”

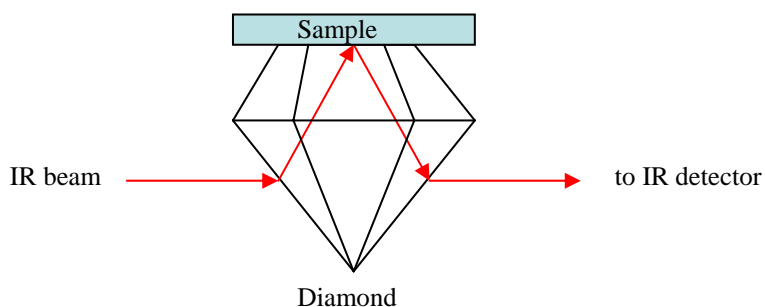
This question is often asked in regard to machine deposits, spots and defects in products, odour from processes/products or even to identify the contents of an unlabelled chemical drum.

There are a variety of techniques that can be applied to this situation. If the unknown substance is basically organic, then Fourier Transform Infrared Spectroscopy (FTIR) is usually the first port-of-call. FTIR provides a complex spectrum which is often referred to as the chemical fingerprint of a compound. Thus the FTIR spectrum of a deposit can be compared with the FTIR spectrum of mill chemicals to see which one is causing the

problem.

Recent advances in FTIR have been mainly focused on the sample presentation techniques. For example the “single bounce” ATR (1-ATR) accessory allows the analyst to successfully analyse spots down to 1mm in diameter. The 1-ATR uses a high-refractive-index diamond to focus the infrared beam on the sample spot and obtain a surface spectrum.

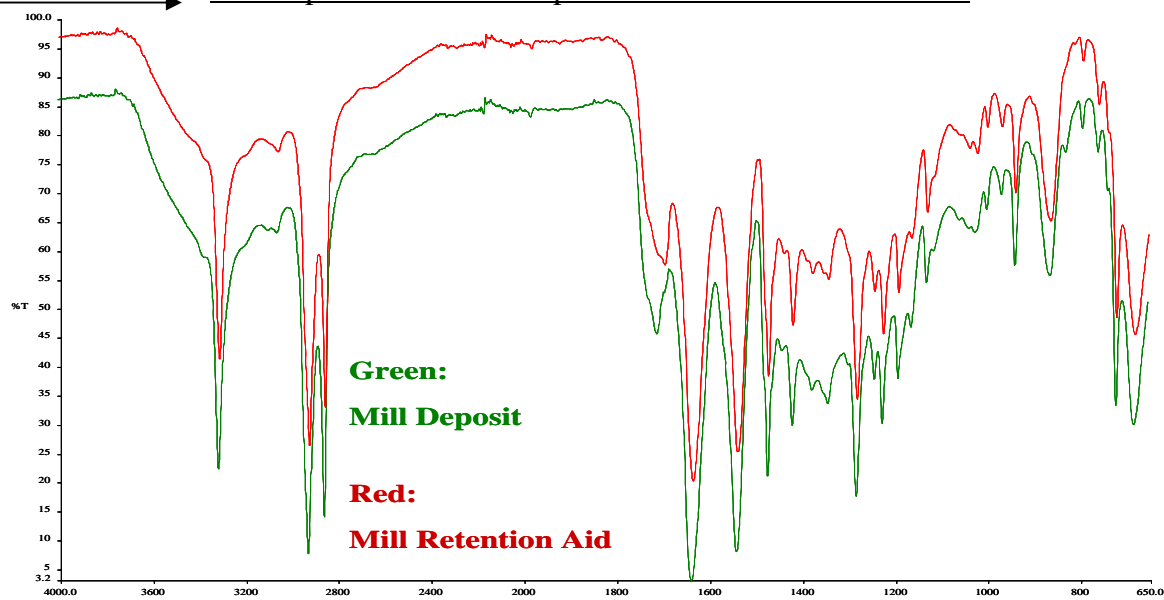
Single Bounce ATR Accessory



Furthermore, FTIR-microscopy, multiple ATR, circle cells, gas cells, liquid cells, traditional cast film techniques and KBr discs provide such a wide variety of sampling techniques that almost any sample can be evaluated by FTIR.

FTIR spectra can be interpreted from first principles. Each peak in the infrared spectrum correspond to a specific molecular vibration - close examination can identify the major chemical groups present in a sample and these can be pieced together to identify the compound. This is a long and tedious process often complicated by the presence of multiple chemicals in the one sample.

FTIR Spectrum of Mill Deposit identified as Retention Aid



Alternatively, the sample spectrum can be searched by the FTIR computer against a library of known compounds. This is great, provided your compound is in the library. Commercially available FTIR libraries tend to focus on single pure chemicals, but most mill chemicals are chemical blends, thus confounding the library search. There is really no substitute for comparing the spectra of actual mill chemicals with the sample – all you need is a library which includes all your mill chemicals.

Creating a mill specific library is not that difficult – we just run FTIR spectra on the chemicals and save them in a searchable library. Then, whenever you submit a deposit or spot for identification the full chemical profile of your mill is available for comparison. This saves valuable time and money when it comes to sample analysis by:

- not having to run reference samples with every unknown sample,
- avoiding delays in waiting for requested reference sample to arrive and being able to prepare composite reference spectra based the presence of two or more chemicals.

Current Australian research on FTIR is utilising the ultra-high energy infrared beam at the Synchrotron to enhance the sensitivity, but this is still along way off as a commercially available service.

FTIR is not the only qualitative technique available to industry. Amongst the other techniques are:

- Nuclear magnetic resonance spectroscopy for complex organic compounds,
- X-ray diffraction to determine crystal structure,
- X-ray fluorescence or electron microprobe for elemental composition.
- Scanning electron microscope with EDS for elemental mapping.
- Optical microscopy and staining for identifying wood fibres or microbiological species.
- Chemical spot tests for a variety of specific compounds.

In summary, there is a great variety of chemical analysis techniques available to industry. Even within FTIR, there are a large number of sample presentation techniques available. Knowing which technique to use is often difficult. The quickest way to determine your analytical needs is to discuss the issues with your analyst (or me, if I'm

not already your analyst). Your analyst can provide advice on the most suitable analytical technique as well as advice on sample collection, sample preservation (you don't want the sample to change between collection and analysis), the need for reference samples and any other considerations.



Feng Shui

Geoff Covey

Most of our readers will be familiar with the ancient eastern art of Feng Shui which brings happiness by balancing female and male power and energy. However, few are aware of its real history and of how it developed. This article will correct this deficiency.

Feng Shui is indeed ancient and from the East. It can be traced all the way back to 1973 and Maine (which is about as far east as one can get in USA). That year witnessed ongoing tension between Chuck and Buffy Clagghammer of the state of Maine. Mrs Clagghammer persistently pressured her husband to throw away most of the contents of the garden shed and to arrange the residue tidily on the shelves, preferably using colour coding.

Mr Clagghammer always replied that the 'stuff' in the shed was useful and expensive to replace, that he knew where everything he wanted was located, and he was the only one who used the shed except when Buffy looked in the door once a week to see if it had been 'tidied' yet.

After three months Buffy had made no progress so she switched tack. She told Chuck all about this

wonderful (but in fact fictitious) article she had read in “Women’s’ Self-Help and Awareness Weekly” about the ancient art of Feng Shui (the name derived by jumbling the letters in extracts from the local Chinese Restaurant menu). She explained that if people removed all surplus items and clutter from their life they would be so much happier, and what better place to start than the garden shed. Chuck was unimpressed. Buffy suggested that he should read the non-existent article, safe in the knowledge that he would regard this as worse than cleaning out the shed.

Nothing happened for several weeks, except that every time Chuck had a small misfortune such as a parking ticket, a mild head ache, or missing his favourite T.V. program Buffy explained that this was solely due to his bad karma and that if only he would tidy the shed in accordance with the principles of Feng Shui, his life would be so much better.

Eventually Chuck succumbed and spent an entire week-end sorting out the shed in accordance with the principles of Feng Shui as interpreted by his wife (who else could do this). When he got home from work on Monday he found that most of the freed-up space in the shed was now occupied by Buffy’s back numbers of “Women’s’ Self-Help and Awareness Weekly”.

Next door to the Cleggbammers lived Erma and Lincoln Zatz. Like many women, Erma had great difficulty in imagining what the room would look like with the furniture rearranged and spent a lot of time urging Lincoln to move items around so that she could decide that “No that is not how I had hoped. Will you move it back to where it was before. No, the dresser was a bit more to the left before you moved it, why don’t you remember these things?”.

Lincoln was getting fed up with this and beginning to resist. Over a cup of coffee with Buffy, Erma was complaining about Lincoln’s unreasonableness. Buffy shared the secret of Feng Shui. Erma set to work and after only three weeks of pressure about why she was only nagging because the bad Feng Shui of the furniture was affecting her inner balance, Lincoln spent most of the next Saturday moving the grand piano from the basement up three flights of stairs. And most of Sunday moving it back again because the new Feng Shui was still not right after all.

The following Thursday Erma made her weekly phone call to her sister Belladine in California and ecstatically explained the success of the new technique. Belladine immediately saw potential in the method for curing her problem. Every Friday evening her husband (Leo) played pool in the family room with his best friend. Belladine did not much care for her husband’s friend and thought that her husband could better spend his time with her watching reruns of “Project Runway”. Most Saturday mornings Leo would wake up with a mild headache and (foolishly as it turned out) he had explained several times to Belladine that it had nothing to do with the beer he had drunk the previous evening but was probably due to stress.

Belladine struck. Obviously, she explained, the stress came from the pool game and a lack of balance. Clearly Leo and his friend were not considering Feng Shui in their pool game and were failing to ensure that all of the balls were in a perfectly symmetrical arrangement after each shot, but not to worry she would selflessly join them and keep a check on the symmetry of the balls for them. After two weeks Leo’s friend stopped coming round on Fridays.

Now Feng Shui was in California and there was no hope that it would not spread or any doubt that people would start taking it seriously. The final blow was struck when Belladine mentioned it to her best friend who was a publisher of self help books (including “Women’s’ Self-Help and Awareness Weekly”).

So now you know the history of the origins of Feng Shui. It is indeed about the balance of female and male power and energy – Female Power directing Male Energy!





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