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My name is John Coleman. I am a mechanical engineer who started professional life in deep-level copper mining in South Africa. From there I spent two years in the chemical industry before joining Universal Leaf Tobacco Co. in 1972. In my 31 years with Universal, the last 20 as head of worldwide engineering, I gained broad exposure to growing and stemming techniques in most countries where tobacco is grown and processed.

I am not going to present any new ideas. I am going to focus on old ideas and ask what purpose they really serve today and whether any justification can be made to perpetuate them.

Until 1964 the tobacco business had been unrestricted and high-margin, creating many large fortunes. With the release of US surgeon-general Luther Terry's report on smoking in January 1964 and subsequent legislation in the USA in 1965 and 1969, all that changed. Margins decreased and pressure was brought to bear to cut costs in all areas of the business. This soon led to changes in the USA and Canada to streamline the processes, but in other countries where labor was cheap, little changed. Cheap labor is no justification for perpetuating traditional practices long after they have outlived their usefulness.

Engineers deal in fact and logic. We believe in the credo "In God we trust, everybody else bring data." The focus of my presentation today is to examine four common practices in tobacco processing to see if they can be justified by objective examination of the data. Of course there may not be valid data in some instances, in which case it would be worthwhile to get them. There is nothing new involved, in fact the problem is that they are old. All these practices have been discussed many times before and no action taken, but like the national debt problem of the United States, the time has come to do something.

I'll begin at the farm with an assault on the humble bundle, which is still used in many countries. In the late 16th century Sir Walter Raleigh sponsored an expedition to start a colony in the New World. A small group of settlers was landed in what is now North Carolina and observed the native inhabitants smoking tobacco. They prepared the leaves in bundles for curing, and we are still doing it today! The bundle is formed by wrapping 20-40 similar leaves around the butt-ends with another similar leaf and tucking the end between the leaves to secure it. It is estimated that each bundle requires at least one minute to assemble. Does this really serve any useful purpose today, and if so, what? Defenders claim it encourages the farmer to grade leaves more precisely. Is this true? If bales are inspected at the time of purchase and mixed bales fetch a lower price than uniform bales, is it not in farmers interest to grade his bales with or without bundling? Is the strip product from regions which no longer bundle inferior to that from those which do?

From the farmers' and processors' standpoints the bundle is a time-consuming and expensive unit. In making the bundle, the farmer crunches the leaves together in his palm, which curls and folds the lamina. The tie-leaf must be cut before conditioning and the conventional bundle-busters working on dry tobacco create considerable fines. The bundle-buster is never 100% efficient and so some bundles are not broken apart and get inconsistent conditioning. They must then be broken manually by the picking personnel. The tie-leaf is curled and cut and so is a candidate for butterfly lift in the separators, creating objectionable stem in the strip.

So what data is necessary to make a judgment? The quality issue is very subjective but the best that can be done is to select certain farmers to straight-lay leaves without bundling and compare these bales with those from farmers who continue to bundle. The fines generation can be measured easily as the two products are run, one though the bundle-buster, one bypassing it.

The important part is to construct meaningful tests and perform them meticulously. Tobacco is a very variable natural product and it is often difficult to test precisely. Before accepting any data as valid, it is vital to understand how the testing was conducted and which data were involved. To claim a certain improvement is invalid unless all other conditions were held constant during the test. In many cases tests are simply inconclusive, meaning that natural variability is as great as the differences between two different conditions.

The next question is "How should the farmer package his leaves in a way that does not damage them, economizes on space, is manageable to load and unload and protects the leaves during transport?" This question then raises the question of the advantages of tipping the leaves. Before addressing both of these it is necessary to understand the mechanics of threshing. During my years in the stemming business I devoted considerable time to testing and experimenting with different threshing techniques, including high-speed filming of the processes. I concluded firstly that the conventional tooth and basket system was the best compromise between efficiency, capacity and durability. I also concluded that the threshing itself occurs as the teeth impact the leaf and the basket serves as a mechanism to size which particles continue to separation and which must be recycled to be threshed again. The more recycle that occurs, the more small particles are generated.

There is no question that the ideal leaf entering the thresher should be moist, hot and open. This is a strong argument for straight-laying of leaves in the farmer package. Leaves which have been twisted and folded may open to some degree during the conditioning process but they will not offer as good a target as a flat leaf. A bale made from straight leaves will also flake easily without cutting during the feed process and therefore less fines will be generated. Obviously straight-laying is not an option where mechanical harvesting is used.

The size and weight of the farmer bale need to conform to the conditions of the growing region. Aside from the USA, most countries favor a bale weighing 40-50kg which can be lifted by one man. The length needs to be at least that of the longest leaf and a typical bale is about 90x60x30 cms. This gives a density of about 300 kg/m3. It is very important that this bale is handled as little and as gently as possible. If the outer layer dries out and becomes brittle, bear in mind that a 2.5cm layer over all six sides of the bales constitutes about 28% of the volume of the bale. The more the bale is lifted, dropped or rolled, the more fines will be created in this outer layer. This risk is greatest in areas with dry climates. The cycle from farm to stemmery input should be as short as possible to minimize handling.

If we conclude that the bundle today serves little useful purpose, the next procedure for discussion is tipping. Does the tipping process offer a better strip, better yield and higher production through any given system than whole-leaf threshing? Many comparison tests have been run over the years, but have these tests been run correctly? Firstly, a "better strip" must be qualified. Modern cigarette making machines perform best with a uniform product, ideally in the ¼" to ½" particle size range with uniform stem content. Large tips in the strip cause two problems. Firstly, long cut strands may tangle in the maker feed mechanism and secondly higher variability in stem content causes a higher reject rate. Multi-cuts ameliorate the first problem to some extent but do nothing for the second. Have tests been run comparing maker efficiency running 100% tipped and threshed strip to 100% whole-leaf threshed strip?

Tests have certainly been done comparing yield. However, they have generally been done running whole-leaf threshing on a line set up for tipping by operators accustomed to tipping. In a tipping system, most of the stem is taken in the tip and the threshing-line is run at low stem content to compensate. The threshers are acting upon shorter leaves and stems and are therefore less efficient, requiring tighter tooth-spacing and smaller basket apertures. A whole-leaf system for the same production-rate requires a different set-up, with larger cylinders, more threshing and separating. In addition, yield comparisons even using identical set-ups, are difficult. The tobacco must be from the same areas, at the same average moisture, of the same age, stored in the same conditions, picked to the same extent, run to the same specs at the same rate under the same ambient conditions. This is almost impossible to accomplish, so yield-comparisons can only be made using averages over long periods. In my opinion, having dealt with both systems over many years, yields depend mainly on the bale moisture at purchase, the amount of fines and sand in the bale, the amount of fines generated during processing and the ability to run close to upper target limits without exceeding them. I do not believe tipping offers better strip yields.

Whole-leaf threshing is a far more efficient process than tipping and threshing when it comes to the feed. Bales can be fed directly or flaked or cut mechanically before being conditioned a DCC, thus eliminating the traditional blending-line, tipping knives and bundle-busters. Not only does this save considerable labor, but also the downtime and maintenance associated with the blending-line. By using leaf silos after the DCC, the feed can be well blended and the moisture equilibrated. Discharge from the silos can be precisely controlled, providing the important constant flow to the rest of the process. There are no large particles or stems to handle in the dryer, giving lower standard deviation in final moistures. With constant flow and uniform moisture, threshing and separating can be optimized and standard deviations minimized. The first-stage threshers act upon whole leaves with full stems, creating less fines. Whole stems separate better and separators can be set to lift free-lamina efficiently. The final strip product falls in the ideal range of maximum >1/2" and minimum <1/4". With correctly sized conditioning and threshing equipment, no loss in production occurs. When building a new plant, a whole-leaf threshing system is less costly than a tipping and threshing system. Although more threshers and separators are necessary, space, energy and maintenance are saved by eliminating the conventional blending-line and separate conditioning, picking and separating associated with the tips.

The next process for scrutiny is manual picking. I know a great deal about picking as my first assignment after joining Universal was the installation and commissioning of automatic picking machines in all its US and Canadian plants. The previous manual system involved splitting the flow after conditioning on to multiple slow conveyors, each carrying about 250 kg/hr at a speed of 20 m/min. Even at this low rate, there was not a monolayer of tobacco on the belt. One or two pickers per belt stood for shifts of 8 hours and did their best to remove certain colored leaves and NTRM. There were two basic flaws in this set-up: no-one can concentrate without interruption for 8 hours and certain small particles cannot be easily removed from a moving belt.

We installed two types of automatic picker, both based on photo-diode detectors sensing the reflected light from leaves as compared to a constant background plate. Filters before the photodiodes used wavelengths where color distinctions were greatest. Thresh-holds were set and leaves falling below these were rejected by air-jets. Each machine handled the same 250 kg/hr but the belts were sped up to 180 m/min to give a real monolayer.

When correctly adjusted and maintained these machines did a surprisingly good job. The problem was the human perception. Each manager or customer who came by the system had a different idea of what should be removed. It seemed every 30 minutes we were asked to adjust the 50 machines. It was also strange that several large manufacturers who ran their own stemmeries did almost no picking. In the end interest in picking declined and the machines simply became expensive flow-dividers and were eventually removed and junked.

The industry then concluded that rather than dividing the flow so that each picker scanned his or her own flow, flows should be combined so that multiple pickers scanned each belt, the justification being that what one picker missed, another would remove. The emphasis shifted from color picking to NTRM removal. The problem with this is that combining flows results in carpet-depths of 10-20cm and when searching for small NTRM only the top layer can be scanned effectively.

The entire NTRM issue has been driven by the fear of litigation. In reality, in any industry involving agricultural products, it is impossible to guarantee a totally pure end-product. Obviously normal and reasonable precautions must be taken to remove contaminants, but is the current manual picking procedure really accomplishing much? Depending on the degree of contamination, the flowrate and the fatigue of the pickers efficiency may vary from 10% to 50%. So is all the associated machinery and manpower really justifiable?

The most efficient system is unquestionably electronic scanning, which if properly maintained and operated can consistently deliver at least 80% efficiency on removal of most contaminants. The problem is that these systems are very costly. The question is, it is better to spend less money every year to get an average efficiency of about 30% or a larger sum every 10 years to get 80%? Of course, 80% means 20% left in the product. How much is too much? Has any smoker died as a result of smoking a cigarette containing non-tobacco material? Nicotine itself is a deadly poison so do minute particles of other materials really pose a health hazard? Of course that is no longer really the point when it comes to litigation. The trial lawyers look for any excuse to sue and science and reality play little role. So if the manufacturer cannot guarantee total freedom from NTRM he is merely reducing the risk by asserting that the most efficient means of removal were employed.

There are two types of scanner currently in use with good results: the laser-based and the camera-based. I personally favor the laser-based because it does not require a separate lighting source, does not create shadows and the source is protected by a lens close to it which minimizes the effect of dust accumulation. The camera systems rely on separate lighting which may vary in intensity and cause shadows. Also, the protective glass is under or over the tobacco so any dust accumulation is in the field of focus. These systems can be fitted in one or multiple stages of the flow, ideally before threshing on a coarse scan and before drying for small contaminants. Rejected product which is mixed with tobacco can go through a second scanner or be discarded. Picking this stream manually has proved very inefficient and often defeats the purpose of the expensive primary scan by returning contaminants to the flow.

The last point for discussion is the means of testing the products from the stemmery. The physical laboratory has remained unchanged for 60 years except for advances in weighing devices. The entire process is subject to distortion by mechanical defects and human error. Various attempts have been made to automate the processes but the industry has been reluctant to consider changes. There are three components to the quality measurement issue. Firstly, are the original criteria for measurement still valid? Secondly, are the sample sizes at today's flowrates still representative? Thirdly, is the methodology the best available today? The answers to all three are probably no. The industry needs to re-define acceptable specifications given today's cutters, makers and cigarette criteria. The measurement of packed-temperature does not necessarily reflect the true peak the case may attain so target values are really assuming a constant error. Non-contact means of moisture measurement measure total water in the field of scan and therefore are distorted by variations in density. However, if the variations in density are minor and multiple scans are taken, the non-contact systems give instant results without destroying product or utilizing expensive labor.

In conclusion, having discussed these four areas, what should be done? As in any business, the customer must support any changes but the supplier can play a major role in analyzing the processes, obtaining and interpreting the data correctly and providing solid evidence to the customer that the proposed changes are mutually beneficial. It is in everyone's interest to rid the system of deadwood and make full use of all the formidable technology available today to develop a lean and efficient process.