The Hidden Costs of Average Forming Sets

Users of average forming sets may be conditioned to accept the associated limitations and higher operating costs without realizing that solutions are possible. This paper helps to clarify what it is that users should demand from their forming sets and illustrates the benefits and productivity improvements that can be achieved.

Presented by:

Why use an average forming set?

An average forming set is one that, at a minimum, passes company policy on hygiene and safety and produces bags which can be sold. It might be heavy, but you can get it on the machine and it works. It might take a little bit of adjustment to the collar or the tube when you first receive it, but you have good mechanics and it is never too long before they're happily running empty bags. The film may track off to one side of the collar sometimes, but you've thought about that already and your seal is little oversized so you rarely lose the back-seal. Even when that does happen, you have operators standing by who can get the mess cleaned up, reset the tracking and get the machine into production again in very little time.

Capital equipment purchases must support the basic strategy that the underlying business is trying to achieve. There is a limit on how much you can charge for your chips or your candy or frozen vegetables and so there must be a limit on how much you can spend on the equipment that bags it. Since no company is exempt from controlling costs, it seems on first inspection that you have to trade off price versus quality to arrive at the vendor and product specification that is right for your business. Quite often that points to buying an average forming set, one that just about gets the job done.

What we see is slightly different however and this paper sets out to explore this. We see customers saving a few hundred dollars buying forming sets whose shortcomings then cost thousands more dollars in the long term. Where it might be seen by some that forming set investments are price versus quality, what we see is that it really comes down to price and quality working in tandem to give the lowest total cost of ownership.

Quantify the quality of your equipment

In order to illustrate the discussions that follow a little more clearly, it helps to think about what is happening to the Overall Equipment Effectiveness (OEE) of the VFFS machine when average forming sets are running on them. The OEE is a very straight forward concept that tries to measure the variation between what a productive asset is producing, compared to what it could produce.

Overall Equipment Effectiveness

Availability	x	**Performance**	x	**Quality**
Running Time / *Net Operating Time*	x	*Actual Output* / *Target Output*	x	*Good Output* / *Actual Output*

Fig 1: The OEE Calculation and constituent elements[1].

[1] p.33, Productivity Development Team, 1999: "OEE for Operators: Overall Equipment Effectiveness", Productivity Press, New York.

The OEE is a percentage composed of three elements multiplied together. The availability element looks at what percentage of the planned operating time the asset is actually running. At any point that you might expect the asset to be running and it is not, the overall effectiveness of the asset is clearly being compromised. The next element, performance, looks at the throughput of the machine when it is available. When it is running, is it running as fast as you intended? Is the target output lower than it could be simply because of practical experience? Finally, quality tries to capture whether or not the machine is producing acceptable outputs. Even if a machine is running for as long as you intended and as fast as you intended, if too much of what is produced is rejected (whether internally by quality control measures or externally by wholesalers, retailers and consumers) then the machine cannot be considered effective. Familiarity with OEE is not essential here; virtually any lean manufacturing theory would work or indeed just some old-fashioned original thinking. The key is to constantly ask 'Could that be better?'

Get down to business quickly

Whether installing a new former for the first time, or an existing forming set during a product or bag size changeover, clearly it needs to be done in a timely manner. If the collar has been installed twisted relative to the framework, then it might be necessary to call a mechanic to correct this. In addition to the machine not running, which affects the availability element of the OEE, we have a mechanic possibly taken away from planned maintenance elsewhere, affecting that machine's OEE. Conversely, if the decision is made to run with the twisted collar, then whilst the availability of the OEE remains intact, the resulting creases on the front panel of the bag may impact on the quality element. Markings on the front panel of the bag may not be sufficient to create an internal reject, but they will be visible to the final consumer and this will influence their impression of the equipment being used and ultimately on the overall reputation of the product and producer in the mind of the consumer.

Similarly, if the geometry of the collar is incorrect making the forming set extremely sensitive to film roll position, final roller position or tension roller settings, then either the operator or the mechanic is going to spend time getting everything set up just right. This is time that could be used to make saleable bags, but instead those bags will have to wait while the shortcomings of the average forming set are compensated for with the valuable time of employees of the food producer. No doubt a whole series of empty bags will be produced during this operation and the cost of that film is always significant. Taken as a whole, food processing and packaging industries in the United States spend 15% of their total variable costs on packaging materials[2], certainly more than is spent on forming sets. Whatever the true percentage is within any particular plant or business unit, it is bound to be significant and resources that cost money cannot afford to be wasted just because they are plentiful. Of course, as soon as payback is reached through reduced film wastage, the forming set which was more expensive to purchase, but then wastes less film, has an increasingly lower total cost of ownership.

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[2] Esse, 2002, cited in Brody, Bugusu, Han, Sand and McHugh, 2008: "Innovative Food Packaging Solutions", Journal of Food Science, Vol. 73, No. 8, Chicago.

Protect your machine throughput

A key function of the forming set is to transfer the required product dose from the outlet of the scales and into the formed bag. All forming sets should be able to do this, but instead of viewing the situation with a "Pass/Fail" perspective, assessing product flow capability in terms of the Performance element of the OEE highlights the hidden costs of using average forming sets. Performance, as noted earlier, is the ratio of Actual Output to Target Output and is generally impacted in two ways: small stops and reduced speed. It aims to capture the effect of anything that will stop your VFFS machine from running at the maximum possible speed for a prolonged period of time.

In this context, small stops are almost exclusively due to a product blockage event. Such events never normally take more than a few minutes to clear and reset and they rarely require the attendance of maintenance staff. They are almost considered a fact of life in many plants and surprisingly few food producers measure the number of events occurring on each machine on a daily basis. Those few that do measure blockage frequency know that these events really hurt their performance rating on the OEE. Equally, many operators overcome likely product blockage by reducing their target speed, a move which can have detrimental effects of its own. The benefit with this approach is that there is none of the wasted film associated with product blockage. Conversely however, slowing the machine down takes away the short term problem and with it the appetite for finding a long term solution. Over time, those reduced speeds become embedded and the problem itself becomes more deeply masked.

For those producers using an average forming set and suffering from product blockage or reduced speed, it is important to know that it does not have to be this way. Forming sets can be designed with very simple features that take a dose of product and stream it through the bottleneck area where the tube by necessity has to be at a lower diameter than the bag column. Blockages occur for a whole variety of reasons. Sometimes the average product unit size is large relative to the bag size. Sometimes upstream process problems deliver a small number of over-sized product units. Perhaps the product itself has a very low mass density or a high surface roughness. Whatever the root cause, it is helpful to think about product blockages in terms of probability. Any one of those features mentioned can increase the likelihood of a blockage and it is important to combat this by ensuring the forming set lowers product blockage likelihood to its lowest possible level.

This can be done in a number of different ways and the graphics below illustrate just some of the options available. Most forming sets outside of the snacks industry are provided with a straight tube. These tubes tend to have an inlet chute of some kind mounted above them. Issues arise with this type of tube since there is no gradual transition from the chute into the tube and the entire product dose is trying to get into the low cross-sectional area at the same time. Those familiar with packing potato chips will know that this kind of tube would almost always cause problems. Potato chips have a low mass density, often with a high surface roughness and often with a wide variation in unit size. This product requires an integral chute, one that is built into the tube so that the transition from large to small diameter occurs over the largest possible distance. Since the angle formed by the integral chute with the vertical axis is steeper at the front of the tube relative to the back, on average, chips at the front will reach the low diameter section of tube marginally before chips falling at the rear. This streaming prevents enough of the chips from simultaneously making contact with both the tube wall and other chips to cause a blockage event. Similarly, the high cut feature shown on the right assists with product flow by increasing the cross sectional area of the bottleneck region that product has to get through. Instead of sitting at a constant radial offset from the inside surface of the forming shoulder, the tube in the rear region is designed to sit directly above the forming shoulder lip and thereby maximize the bottleneck area. As with all product flow considerations, it is a very subtle feature that can have significant and measurable impacts on product blockage frequency. The challenge for the equipment supplier here is not so much in generating the ideas, but in being capable of repeatedly fabricating such intricate shapes to dimensional tolerances that are much tighter than is normal to reasonably expect from a fabrication. Without computer-aided design capabilities and the specific tooling, it impossible to create forming tubes with the very best product flow performance.

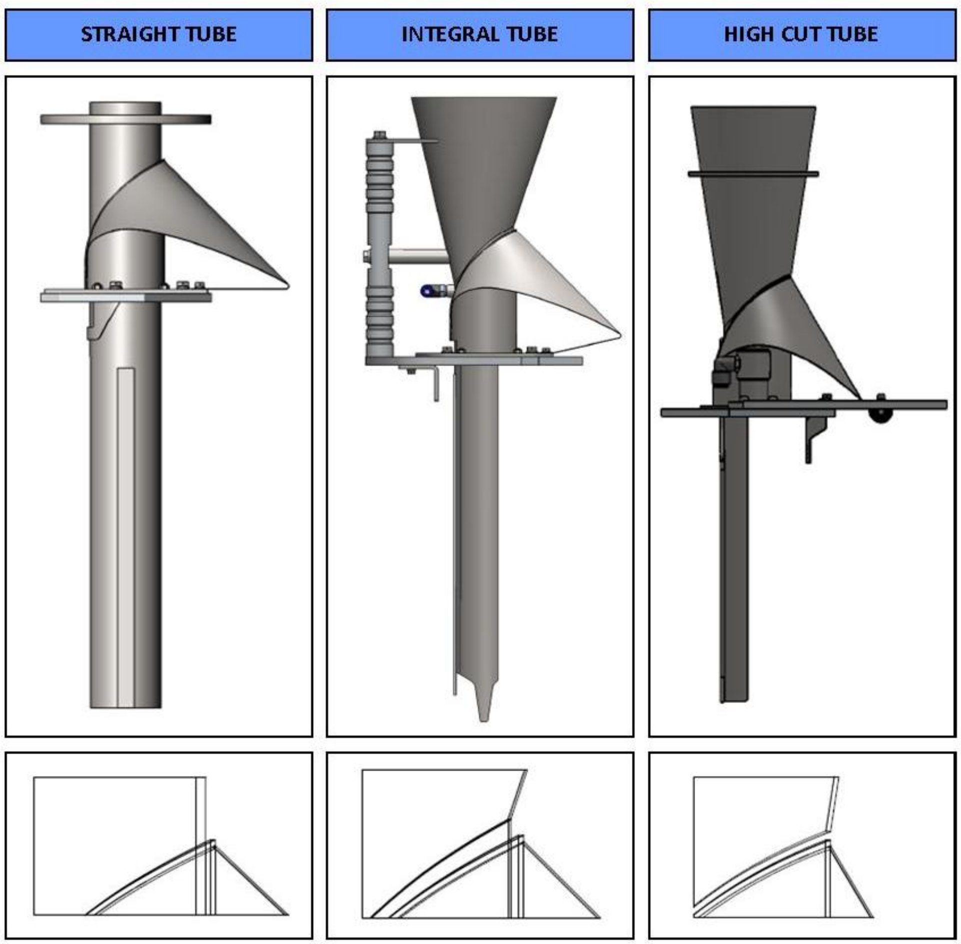

Fig 2: Various tube inlet design options.

Keep your packaging on track

Forming set designs can vary markedly between different machine types but one feature they all have in common is they must conform to the basic principle that the tube must be correctly aligned. The machine manufacturer will go to extraordinary lengths to ensure that the drive belts are square relative to the plate onto which the forming set mounts, and they are normally able to do this with a combination of good quality control and a manufacturing bias towards accurate, machined components. If the forming set tube is fabricated poorly however, or damage has knocked the tube out of alignment, then once mounted, the side flats on the tube will not be parallel and an equal distance away from the center of the belts. This misalignment can mean that one belt applies less pressure relative to the other and consequently the film column contains unequal tension.

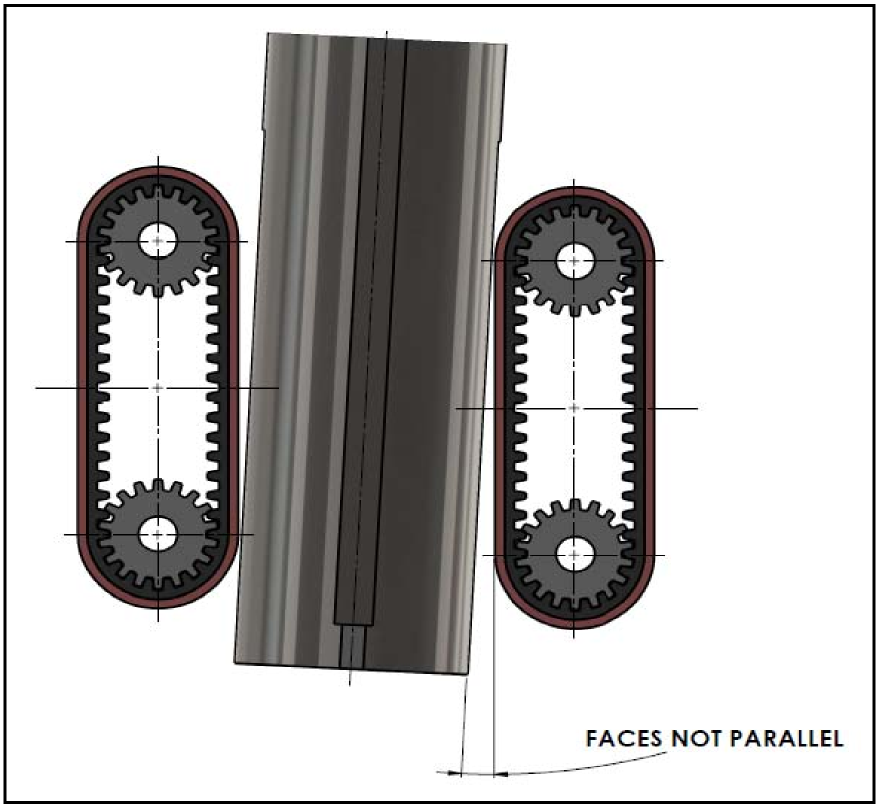

Fig 3: Example of tube misalignment.

This can hurt the OEE in two main ways: availability and quality. Misaligned tubes create areas on the belts that are subject to more wear than they should be, meaning that they have to be replaced at shorter intervals. In addition to the high cost of replacing belts unnecessarily, the machine is also going to be unproductive during the switchover. In cases of belt misalignment it is also possible to notice the film lifting off the forming shoulder very slightly on one side. Particularly with intermittent motion machines, this can cause small horizontal creases on the

finished bag which both reduce the aesthetic appeal and possibly compromise the barrier efficiency of the film structure. Tube misalignment can also be in the front to back direction, as opposed to the side to side direction shown above. In these latter cases inconsistent contact with the heater bar or band can leave the machine producing bags with poor back seals that are, at best, distorted and, at worst, fail to completely envelope the product.
A similar situation to tube misalignment is tube twist. In situations like that shown below, there is again inconsistent contact between belt and tube flat with the likely consequence that belts are being consumed far faster than they should be. The film column is now delivered to the jaws rotated from where it should be and the graphics will be shifted to one side on the final bag. Combined with poor shoulder geometry, the amount of rotation contained in the film column can oscillate leading to bags whose top and bottom transverse seals are not parallel, therefore leading to a bag that is twisted.

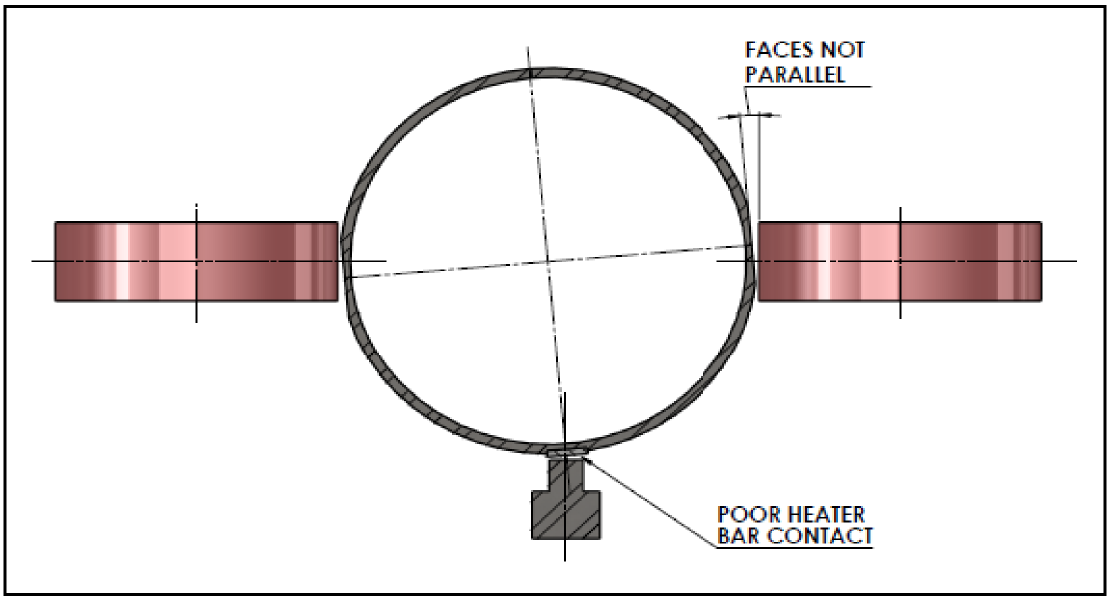

Fig 4: Example of tube twist.

Maintain the back-seals you need

A final key area in assessing whether or not an average forming set is costing you money is to consider the integrity and presentational quality of the back-seal. Issues in the back-seal generally derive from either poor shoulder geometry or tube misalignment, both of which have been touched on earlier as effecting problems elsewhere. In cases where the shoulder is not properly supporting the web of film as it transitions from a flat to a cylindrical shape, the film can wander left to right as natural variations in the resins and additives of the web structure inevitably cause oscillations in web tension both across the width of one bag and from one bag to another.[3] When this is happening, you will see the film ripple as it flows across the shoulder or the film will artificially lift up from the lip. The ideal state is to see a full impression of the shoulder lip protruding through the film at all times and, if rigidized material is used for the collar, an equal impression of this in all areas of contact. If you see something different, it is likely your formers have a geometry problem and this may be linked to a tendency for the film to wander and as such cause the back-seal to change position, exposing or hiding (un)wanted graphics. At the extreme, the back-seal can come apart completely once there is not enough overlap to fully seal the bag.

In situations where the tube is misaligned, as in figure 3 for example, this leads to unequal drive on the two sides of the film column. The effect is very subtle and normally manifests itself as the lip sitting above the lip of the shoulder on the lower tension side. This gives the *appearance* of a shoulder geometry issue but which is in fact an issue due to tube damage or poor tube fabrication quality.

If you're seeing signs of either of these first two issues then the chances are your OEE is being hurt severely. Firstly, if the back-seal is such that new bags fail seal integrity testing or simply burst open upon handling, then the quality aspect of the OEE is clearly compromised. If the machine has to be stopped to reset the film position or make other adjustments then the availability element begins to suffer. In situations where the back-seal is sufficient but the graphics are compromised, the bag is not within specification and so a strict OEE measure would see further decreases in the quality element. The salient point here is that many issues are compounding together to prevent the machine from performing to its maximum potential. Once again, the average forming set is driving down underlying profits.

A final point in the back-seal arena, if you are dissatisfied with the aesthetic look of your seal (quality element), is that once you have established shoulder geometry and tube alignment to be correct, do not be cautious of taking the back seal unit, be it a band sealing unit or a heater bar, back to the OEM recommended settings. Too often we find that settings such as positional clearance to the tube, temperature and run speed (for band sealing units) are adjusted to compensate for deficiencies elsewhere. The result is often a strong but poor looking back-seal. Even once the former issues are resolved, maintaining these settings will continue to result in creases in the back-seal area.

Could average forming sets be holding back your business?

Listed below is a summary of some of the ways in which we see average forming sets impacting on the bottom line of food producers. It is not exhaustive, and is drawn from the discussions above. We have tended to focus on issues that are both very common and can be related back to OEE, which we believe is a useful tool for understanding the underlying concepts.

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[3] p.1, R. Duane Smith, 2002, "Challenges in Winding Flexible Packaging Film", TAPPI, accessed at **http://www.tappi.org/content/events/07place/papers/smith.pdf on 09/25/2012**.

Installation Time	**Availability**	*Former is not 'plug and play'*
	Performance	*Wasted resources (film and product)*
	Quality	*Front panel bag creases*
Product Flow	**Availability**	*Product blockage events*
	Performance	*Slowed target speeds and wasted resources*
	Quality	*Leakers from product in end seal*
Tube Misalignment	**Availability**	*Maintenance time replacing worn belts*
	Performance	*High belt replacement rate*
	Quality	*Horizontal bag creases*
Back-Seal Integrity	**Availability**	*Machine reset time*
	Performance	*Wasted resources from open bags*
	Quality	*Poor back-seal integrity or graphics alignment*

Fig 5: Summary of issues arising from average forming sets.

So what does this mean? Quite simply, teams working with average quality forming sets are very busy people. There are issues to be resolved everyday and sometimes it feels like you have to move a mountain just to maintain production targets. But plants taking the view that forming set price and quality work together in tandem to give the lowest total cost of ownership begin to see some of these issues falling away. The more they look at problems and solve them, the more they create time to solve further problems. They begin to demand more from their forming sets and subsequently hold their vendors to account, getting what they're promised and reaping the benefits of that.

Finally, it is worth noting the connection that producing better bags more easily really does make a difference to the company bottom line. Whilst a good bag may not necessarily attract a new consumer, a bad bag with leakers and creased, misaligned graphics certainly might push that consumer away from your brand. Moreover, a food producer that has poor experience with basic pillow pack bags is far less likely to embrace more complicated bag configurations such as quad-seal bags or investigate the use of thinner and more-environmentally film structures. And it is exactly these types of innovation for which the time and appetite for innovation must exist if the company is going to move ahead of its competition. Demanding more from your forming sets is a good place to start.

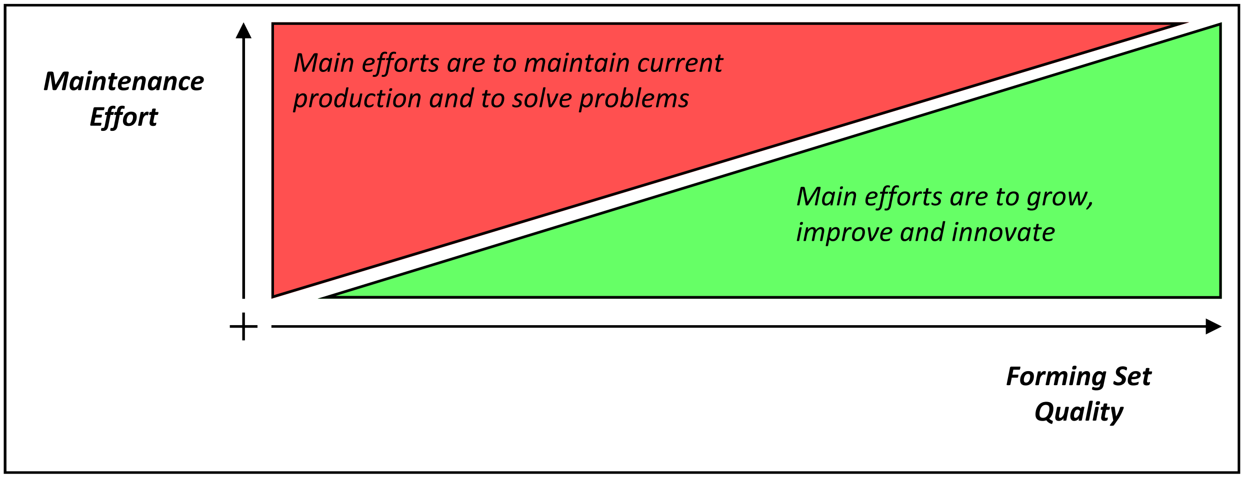

Fig 6: Production main effort continuum.

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