Lean Compounding
The Key to Survival

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The plastics compounding industry is faced with the escalating need to supply an ever wider variety of specialty products within the shortest time.
This results in an increasing demand for frequent formula changes in masterbatch and additive mix manufacturing.

Larger compounding plants, often built in the '80s, employ a high degree of automation and focus on single polymer production in very large runs or campaigns, and in a continuous mode.
Formula changes were somewhat achievable as long as the product stayed within the same product family.
With the growing need for variety the demand for customized- rather then universal master batches increased as well, pushing the 'difficulty' further up the supply chain.
The 'conventional' way to achieve greater flexibility is to reduce automation and employ more operators for simple and repetitive tasks. At present many *Masterbatch* producers work this way, having de-coupled the premix-, extrusion- and packing steps and use manual activity to feed and transfer the batches between the process steps.
The problem with this model is that there are less and less individuals in the western world interested in such production jobs.

More recently the general high salary levels have encouraged manufacturers to consider moving or outsourcing production to lower cost economies. Such a move however is not easy to realise and manage especially for small to medium size enterprises and the risk of failure is very high. Ever increasing transportation costs and the environmental impact of shipping product around the world supports the argument for producing "high variation" goods close to where the actual demand is. Maintaining research and development together with production is also more efficient.

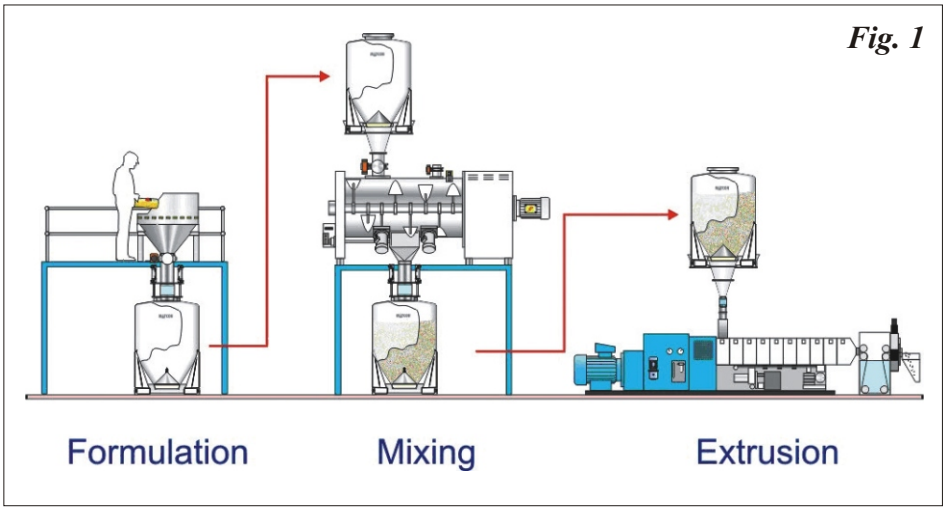


Fig. 1

Specialist compounding companies are faced with increasing quality challenges, driven by the users who issue tighter and tighter specifications. New medical applications but also top quality car paints and bullet proof polycarbonates are only a few examples of the high demands in specialty compounding.
At the same time the quantity per produced unit reduces….
This presents a significant burden in a manually operated plant, as the human factor has to be constantly managed to minimise the risk of errors.

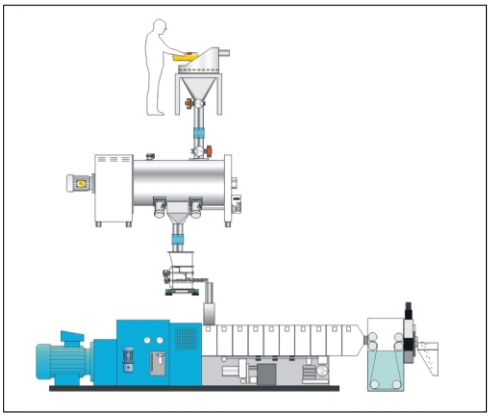
LEAN production theory offers a superb compromise - embracing sensible automation and providing almost instant change-over times by applying "SMED" (single-minute exchange of dies). There are "smart" manufacturing methods available that when correctly applied bring benefits that far outweigh the apparent (and often non-existent) savings of relocating manufacturing to cheap labour territories.

WASTE
In the world of Lean Manufacturing, avoidance of waste is the driving philosophy. The reality for traditional manufacturing is often the opposite waste everywhere:
1. Overproduction - Mixing additives in larger quantities than ordered because cleaning is such a burden.
2. Waiting - operators and expensive process machinery standing idle i.e. due to cleaning activity or awaiting QC analysis results.
3. Inventory - Customer requirements for rapid and "next day" delivery resulting in huge finished goods and intermediate goods storage.
4. Defects - Rework from human error or pigment colour problems discovered when value is already added (extruded).
5. Transporting - additional transportation to and from inventory storage and between processes to meet 'peaks and troughs' of client demands.
6. Over processing - Technology selected on 'worst case scenarios' and applied to the whole as opposed to applying sufficient technology for the application. The 80 20 rule applies in many cases to both process technology and level of automation.
7. Motion - Unnecessary movement of people and product between processes due to poor process flow - additional motion being caused by poor plant / factory layout.

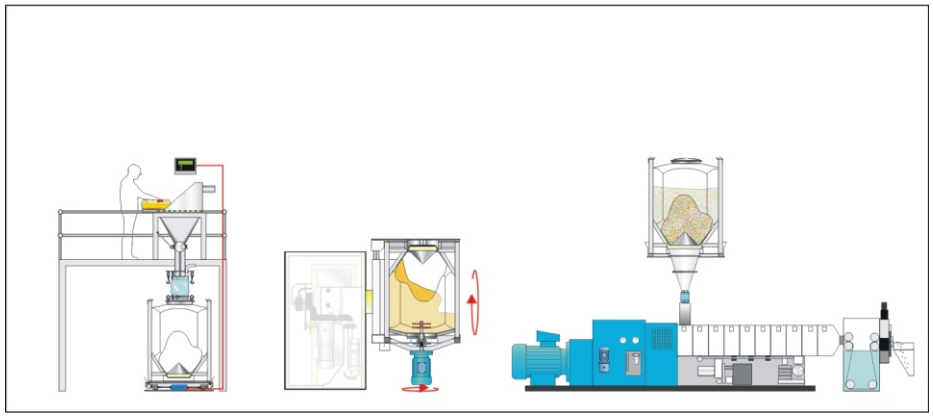
The actual and potential cost associated with WASTE is enormous, leading to higher prices and reduced profitability. Moving the same "wasteful" process to a lower cost economy is not the long-term answer. Smarter manufacturing without waste is the key to sustainable profitability.

Flexible AND efficient with modern IBC technology
Many of the answers to the challenges presented to compounding and specialty polymer producers lies in the use of an "IBC" (Intermediate Bulk Container) system.

ARTICLE



Traditional - OEE 10%



New - OEE 90%

A modern IBC System allows a greater degree of automation, whilst assuring batch traceability with “one batch, one dedicated storage and process vessel”. This allows fast product changeover (SMED) and virtually unlimited flexibility to meet market demand without relying on campaign manufacturing philosophies and large process and finished goods inventory. These solutions are by no means new IBCs have been used for decades, but often had a pretty poor reputation for bad design resulting in dusty and labour intensive plants. The trend shift in the market place has forced most of the significant powder handling system suppliers to focus their development towards modular IBC systems. This has resulted in rapid technology improvements, some of which are described below.

Why use IBCs?

The diagram above illustrates how a traditional pre-blending operation can be separated from both the process of formulating the batch upfront and the more time consuming extrusion of the mixed batch. One blender can now keep up with more than one extruder.
In LEAN terms this means that the 'non value adding' operations (cleaning, loading and unloading of the mixer) can be made external, allowing the mixer availability (OEE) to be close to 100% rather than 5-15% which is the norm with traditional “in-line” systems. Along with huge productivity increases, the system becomes faster and easier to clean. Fig. 1 shows a typical flexible 1-port Masterbatch process. By separating the formulation of the several additives from the pre-blending itself, the mixer 'waiting' (waste) is typically reduced from 30 minutes to 3 minutes.

Extruder feed and 'pull manufacturing'

To avoid intensive cleaning of the sack tip unit, the blender, the screw feeder and the extruder itself after each run or batch, companies used to try producing from 'white to black'. The sequence of extruding is then however not in sync with the way orders come in. This classic form of manufacturing is more 'push' than 'pull' which creates inventory, one of the *wastes*.

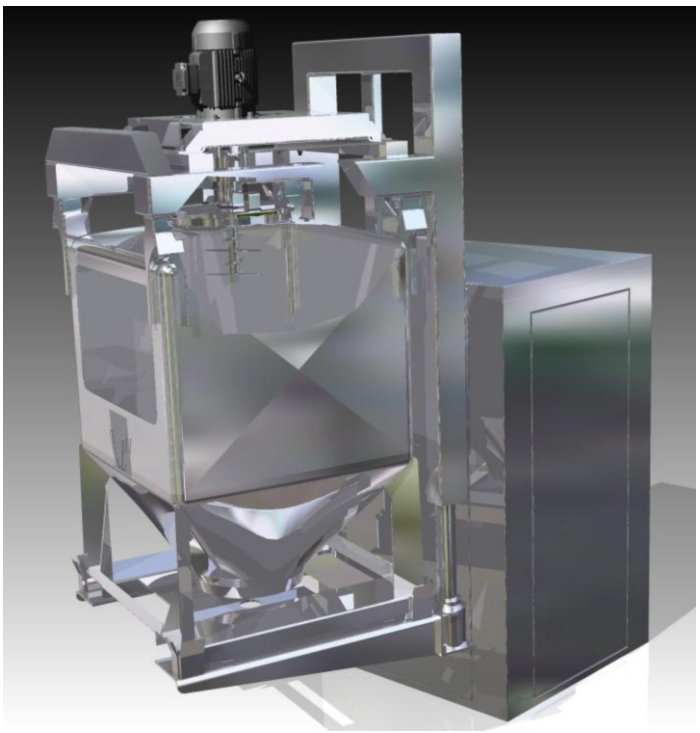
Modern 'cone valve' technology combines two lean solutions for this dilemma. One is the assurance of non-interrupted discharge from the IBC, without operator intervention. The second is the opportunity to control the feed making the screw feeder obsolete. Cleaning of the traditional sack tip unit and the screw feeder arrangement is replaced by switching to a clean IBC discharge station.
The OEE of the extruder improves significantly this way, without creating inventory.

Pre-blending

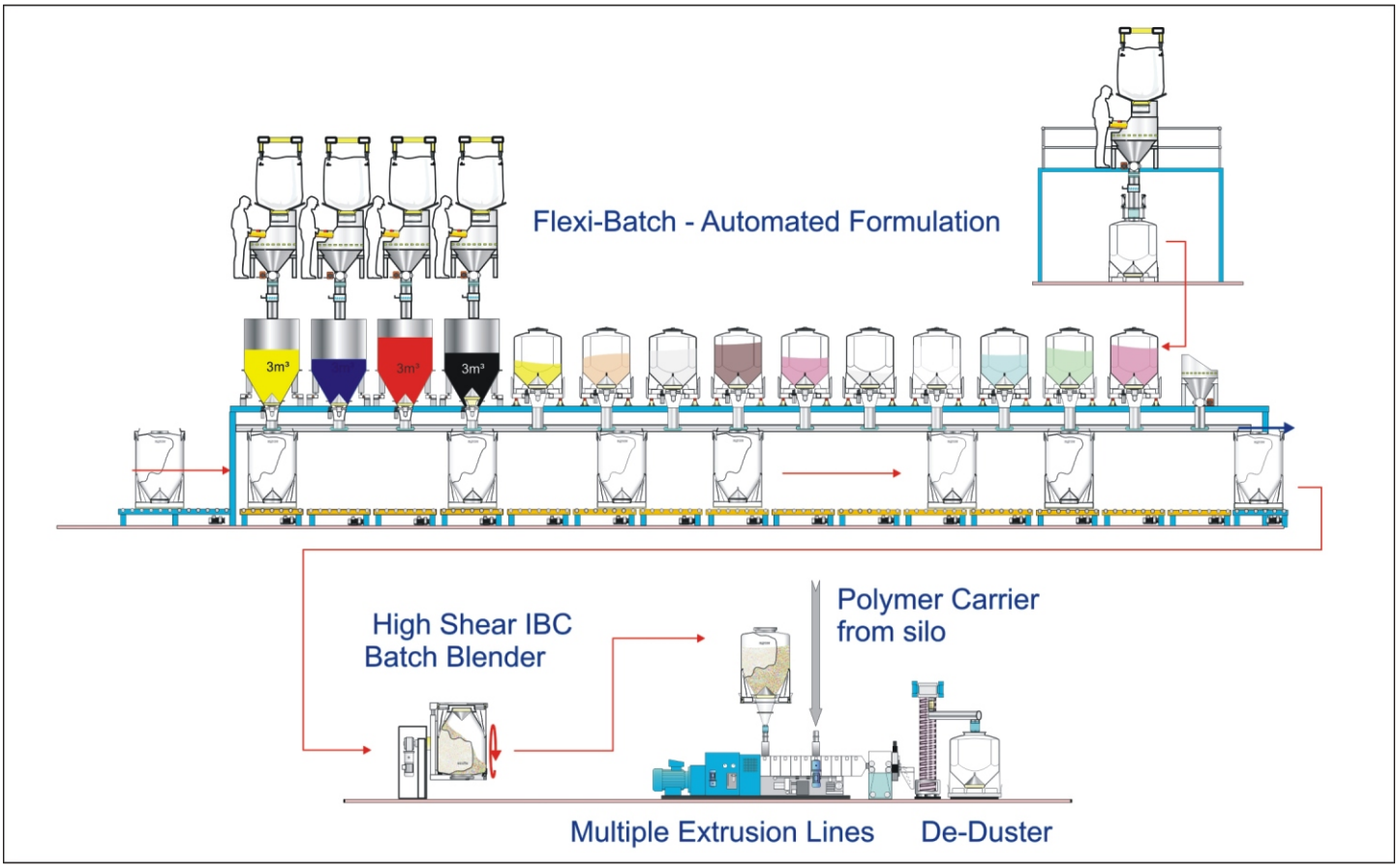
The benefit of charging and unloading a stationary blender with IBCs is clear.
Today's trend is to use the IBC itself as the mixing vessel, totally removing the need for “on-line” loading and discharging of a stationary mixer in the traditional way. But the biggest lean gain is of course the total absence of in line cleaning. The mixing device is immediately ready for the next batch. The cross contamination risks are transferred from the difficult to clean mixer to easy to clean IBCs.

IBC Mixing has been used for decades across many industries providing the flexibility benefits described throughout this article. The challenge has always been how to achieve a good pigment and other cohesive material dispersion - a regular requirement in the compounding industry.

This has encouraged the development of new 'high shear' capabilities with IBC blending. It pushes the boundaries over fixed mixing technology more than ever. The results of these developments are truly astonishing. Smart manufacturers commissioning a new project are likely to seriously consider the use of IBC Mixing because of the wider lean benefits. Along with system flexibility and elimination of 'in process' inventory, one IBC Mixer can achieve 2-4 times the capacity of a conventional fixed mixer, reducing investment cost and space requirements.



IBC Batch Blender with Intensifier



One centralized formulation system can serve many extruder lines.

Blending and rework
The Masterbatch industry is faced with a lot of rework. Root causes are found in colour variations of inorganic pigments, human errors as well as the mixing- and extruder process itself.
The use of *mono batches* allows compounders to adjust colours during the extruder process but this is not very practical when client's unit-orders are relatively small.

It is one of the most beneficial lean exercises to observe and analyse the processes thoroughly and eliminate the causes step by step.

Within the lean philosophy it is important to introduce necessary QC steps as much as possible *before* value is added, so certainly not just after extrusion. The conventional method is to mix the components, take a sample and let the blender stand idle , awaiting the release of the batch.
This waiting is not needed when an IBC blender is used. Simply take the IBC out of the blender and introduce the next batch to it.

Compounding and Batch Formulation
Formulating a batch of typically 5-10 components is a very time consuming and labour intensive task. Smaller operations cannot justify investment for automation, but simply try to improve the working environment. Often larger (> 1000 kg/h) extruder lines are fed using a combination of direct dosing from big bags, direct manual additions and silo originated main carrier polymer. This is all fed into a continuous preblender to avoid needing too many extruder ports. It is clear that complex adjusting of the dosing control systems and the huge cleaning job when switching colours, make these lines suitable only for one product, perhaps in a few grades, and for very long campaigns.

When true pull manufacturing is needed and clients start to order smaller units it is far more lean to use a (centralized) automated formulation system. Provided it has the flexibility to respond directly, with minimal waste, to orders received. Whilst Big Bags provide an appropriate distribution package for medium size raw materials, they offer limited hygiene and dosing capabilities. With a traditional Big Bag formulation system virtually every product requires its own dosing position no matter whether its used often or seldom, making the plant impractical in size and cost (capital and operational).

By decanting Big Bags into Cone Valve IBCs, the same level of automation can be achieved with a 10th of the space and a 3rd of the cost over conventional systems. The "Flexibatch" dosing system combined with smart manual systems for frequently changing micro components can radically reduce the labour requirement in the formulation area. It also eliminates the risk of human error and rework at this critical part of the value stream.

Conclusion
Equipment and system suppliers are constantly innovating to meet the challenges faced by their customers. Lean Thinking combined with new technology has the potential to dramatically improve the efficiency and profitability in any business. Faced with the need to cut costs management teams need to think carefully. Should production move abroad just to take advantage of cheap labour or could existing resources be used to manufacture more efficiently? By adopting a Lean approach with the right technology, improved cash conversion times and reduced wastage could make it more profitable to re-engineer existing plant. But Lean Manufacturing is a not just a physical change. The message has to be championed from the top to the bottom and with the endorsement of all. Lean is a company wide philosophy, not a departmental project.