Pharmaceutical companies are facing increasing competitive pressure to improve manufacturing performance. Patent expiries, weak product pipelines, and potential legislative and regulatory reforms are testing traditional business models built on research, development and marketing. To deliver the returns demanded by investors, pharmaceutical companies must increasingly look to other business functions – like manufacturing and supply chain management – to find performance improvements that maintain profit margins and provide competitive advantages.

Where can manufacturing managers and supply chain managers look for techniques to improve manufacturing performance? The choices are both myriad and mysterious. Buzzwords abound. This article offers two proven principles for pharmaceutical managers that rise above the jargon and are generally applicable methodologies for improving manufacturing performance.

**DIAGNOSIS BEFORE PRESCRIPTION**

Imagine one morning a person wakes up feeling unwell. Most people in this situation would try self-diagnosis to see if they could determine the cause. Thereafter, they might consult family, friends or reference materials. Finally they might seek some third-party medical diagnosis. A logical person would not wake up, bypass the diagnosis stage and then take the latest blockbuster cure that they had read about recently in a newspaper or magazine. After all, what use is a drug for high blood pressure when you have a common cold?

Manufacturing managers should follow the same approach to improving their performance. They should make a diagnosis first – and only thereafter prescribe the appropriate improvement techniques. Managers should be particularly careful to avoid bypassing the diagnostic stage and implement the latest manufacturing blockbuster ‘cure’ or some one-size-fits-all improvement methodology.

The path to improvement, however, is not clear and often everyday commercial pressures can cloud a rational logical decision. In the quest for manufacturing improvement, the choice of tools available can seem like an alphabet soup of improvement techniques (see Figure 1). There is a certain language spoken by those in the know, and many tools and techniques are only ever mentioned by their three- or four-letter acronyms. The problem grows as different industries adopt and re-brand techniques with new terms. When a group of tools is then packaged under an improvement initiative like

---

**Proven Principles for Improving Manufacturing Performance**

Plant managers can obtain major improvements in manufacturing performance by rising above the jargon and implementing just two proven guiding principles that have stood the test of time.

**By Paul Dennis, Senior Consultant at ABB, and Tom Knight, Chief Strategy Officer at Invistics**

Paul Dennis is a Senior Consultant for ABB where he advises on and implements change in a wide variety of manufacturing industries including pharmaceutical, metal, aerospace and consumer. He has 18 years’ experience in manufacturing in a variety of positions, and holds an MBA and a Fellowship in Manufacturing Management from Cranfield University (UK).

Tom Knight is the Founder, Chairman and Chief Strategy Officer at Invistics – a company which provides manufacturing performance management software to enhance performance at pharmaceutical manufacturers. Prior to founding Invistics, he spent 10 years improving supply chains as a Manufacturing Manager at Alcoa and Siemens. Mr Knight has BS and MS degrees in Mechanical Engineering, and an MBA from Massachusetts Institute of Technology (MIT).

Pharmaceutical companies are facing increasing competitive pressure to improve manufacturing performance. Patent expiries, weak product pipelines, and potential legislative and regulatory reforms are testing traditional business models built on research, development and marketing. To deliver the returns demanded by investors, pharmaceutical companies must increasingly look to other business functions – like manufacturing and supply chain management – to find performance improvements that maintain profit margins and provide competitive advantages.

Where can manufacturing managers and supply chain managers look for techniques to improve manufacturing performance? The choices are both myriad and mysterious. Buzzwords abound. This article offers two proven principles for pharmaceutical managers that rise above the latest jargon and are generally applicable methodologies for improving manufacturing performance.
‘Lean Manufacturing’ or ‘Six Sigma’, the picture can be further distorted as people liberally apply these while ignoring other – perhaps more useful – problem-solving techniques just because they are not included in the chosen initiative umbrella.

Evidence gained from visiting many factories in varied industries that have implemented many of these tools and techniques – from ABC (Activity Based Costing) to ‘Six Sigma’ – would suggest that they work well when, just like medical cures, they are applied correctly to the problem for which they were invented. However, unlike medicines that are highly regulated before being prescribed, these tools and initiatives are often administered by people with little training and – even worse – they come with no warnings on misuse and, when applied to the wrong problem, the side effects can easily outweigh any benefit.

One example is the adoption of ‘Lean Manufacturing’ techniques; these originated at Toyota as the ‘Toyota Production System’ and offer unparalleled methods for eliminating waste in high-volume automotive environments. But should these same techniques be implemented in low-volume, high-mix environments like pharmaceuticals? The answer is – not without adoption and customisation to the unique characteristics of pharmaceuticals. The principles of Lean Manufacturing – such as waste elimination and cycle-time reduction – certainly apply in pharmaceuticals. But reaching these benefits with a ‘cookie-cutter’ set of tools tailored to the automotive industry may cause more pain than good.

**TWO GUIDING PRINCIPLES**

So what improvement techniques are most appropriate for improving pharmaceutical manufacturing performance? In the authors’ experience, two guiding principles have stood the test of time and are broadly applicable: they are benchmarking and the elimination of waste – especially the reduction of inventory and long cycle-times.

**Benchmarking**

Documented ways of improving production can be traced back over 100 years – ever since Fredrick Taylor and Henry Ford devised ways to increase output, with less cost and less variability. It is remarkable that many of the so-called modern manufacturing improvement techniques used today are based on theories developed in the 1960s.

Many manufacturing performance problems in pharmaceuticals are common to other industries, and managers can learn from other plants that have had success in solving these performance problems. Why reinvent the wheel? There cannot be many problems in manufacturing that have not already been solved – even though many of these solutions will come from outside the pharmaceutical industry. Taking the simplistic view, the game of Snakes and Ladders (called Chutes and Ladders in the US) can represent the opportunity. Why just roll the dice and see where fate takes you along an evolutionary path, when you can learn from others and start climbing the ladders and sidestepping the snakes? This fast track to success in production can be achieved via the proven methodology of benchmarking.

“Benchmarking is the process of continuously measuring and comparing one’s business performance against comparable processes in leading organisations and against the physics of the process to obtain information that will help the organisation identify and implement improvements.” (1)

The keywords are that benchmarking is a process where you judge performance against the best in the world. This is not to say that pharmaceutical companies have to be the best in the world in every parameter, but it is important that they know what the best in the world is and consciously operate at a position that is different from that point. In many ways, good manufacturing performance is like a game of golf; you do not have to be under par every hole to win the game – you just have to birdie some holes and be average at the others.

**The Elimination of Waste (Especially the Waste of Inventory and Long Cycle-Times)**

Inventory hides waste. It covers up production problems, quality problems and supplier problems. Worse, as long as the inventory exists, organisations have little incentive to fix the problems. The classic analogy is to consider inventory as water that covers and hides rocks in a river (see Figure 2). As the illustration shows, holding large amounts of inventory can hide a multitude of problems throughout the entire supply chain.

![Figure 2: Inventory Hides the Rocks that Must be Removed to Improve Manufacturing Performance](image)
One common strategy for exposing where the rocks are is to lower the level of inventory. This methodology is usually achieved by implementing some form of ‘pull scheduling’ – a cornerstone of Lean Manufacturing. Pull scheduling techniques include Kanban, Drum-Buffer-Rope and constant work in progress (CONWIP). All of these variations on pull scheduling allow managers to decide exactly how much inventory they will have, and then provide tight controls to ensure inventory never rises above this level. Over time, they can iteratively lower the inventory level, exposing problems that can be eliminated before repeating the cycle.

Pull scheduling will quickly expose waste, but it will take a brave person to guess the best inventory level. How can a manager set the optimal level of inventory within a pull scheduling system? The fact is that in a high-volume, single-product company it is easy to set inventory levels, but in multi-site, multi-product pharmaceutical companies it is a very difficult question to answer. Pharmaceutical companies have extremely complex product-mix variety, and extensive demand and production variability.

Fortunately, new operations research algorithms are available in commercial software packages that can calculate the optimal inventory level for pull scheduling systems. The software allows manufacturing managers to see what effect lowering inventory levels will have before the act is carried out. Managers can use the software to calculate the optimal inventory level given the ‘rocks’ in their stream-bed. Even better, they can use the software to tell them what ‘rocks’ should be removed so that they can reach even lower levels of inventory. These packages can be integrated into existing Materials Requirements Planning (MRP) or Enterprise Resource Planning (ERP) systems to speed implementation by re-using data in these systems.

CASE STUDY ON THE APPLICATION OF THESE PRINCIPLES

Bristol-Myers Squibb has employed these principles to dramatically improve manufacturing performance. One Bristol-Myers Squibb facility provides an excellent case study; it is typical in size and scope to many pharmaceutical plants, producing several hundred stock-keeping units (SKUs) ranging from tablets and capsules to syrups, and employing processing technologies such as direct compression, wet granulation, roller compaction, fluid-bed drying, tray drying, tablet compression, aqueous film coating and encapsulation.

Prior to embarking on the change process, the plant suffered from several problems common to many pharmaceutical plants:

- Products had long cycle-times, with excessive inventory and costly material storage and handling
- Late deliveries occasionally occurred due to long cycle-times or a lack of visibility on in-process orders
- Legacy information systems – especially the MRP-based push scheduling system – hampered efforts to cut inventory and improve delivery performance
- The organisation structure was departmentally and functionally focused, making it difficult to promote cross-functional co-ordination or to accelerate product flow

The plant management used benchmarking to identify new methods for operating the plant. Techniques
from other pharmaceutical plants were employed, as well as those from other industries such as chemicals and electronics.

The management also vigorously pursued cycle-time and inventory reduction techniques. They organised the workforce along process-based flow paths, and instituted performance metrics to measure cycle-time and motivate faster flows. Pull scheduling was implemented using Constant Work in Progress (CONWIP) to maintain tight control on inventory levels, iteratively lower cycle-times and eliminate waste. Bristol-Myers Squibb has also utilised software from Invistics to optimise pull scheduling inventory levels.

As a result of these efforts, the plant improved performance to levels near 'best in class' within the pharmaceutical manufacturing sector:

- Units shipped improved by 23% over a two-year period
- On-time deliveries improved to near-perfect, with no missed orders in over 25 straight months
- Changeover times were slashed by more than 50% in 90 days

These improvements are just one example from many that are published documenting the benefits of benchmarking and reducing cycle-times. Managers of pharmaceutical plants can expect similar benefits from implementing these principles in their manufacturing facilities.

The authors can be contacted at paul.dennis@gb.abb.com and info@invistics.com

Reference