The fundamentals of optimizing machine uptime and product yields in capsule filling operations

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This article identifies the core areas that, if well practiced, lead to successful capsule filling operations.

When I was a manufacturing manager in charge of capsule filling, I often yearned to see how other companies ran their operations. What equipment did they use? How had they modified it? How did they overcome formulation, equipment, and environmental challenges?

Since that time, I've traveled to pharmaceutical and dietary-supplement manufacturing sites throughout the USA and Canada. The sites span diverse manufacturing environments, from multi-national corporations to storefront operations. My work at these facilities has prompted me to identify the core imperatives that, if well practiced, breed success. By adhering to these fundamental practices, companies can maximize machine uptime and product yield. The core areas are equipment selection, designed downtime, orchestration, and manufacturing evaluation.

Equipment selection

Successful operations begin with proper equipment selection. You have to have the right tool for the job. Imagine if an American football were substituted for a soccer ball in the final game of the World Cup. The field would be groomed, and the top-level players would be set to compete. But even the most talented players would struggle to perform at their best, and fans wouldn't see the game they paid to watch. It's analogous to what I've witnessed in capsule filling: Good environment, good people, but equipment that is ill suited to the task.

A cautionary tale. I know a medium-sized nutritional company that was the first to invest in a new technology to help it meet demand. The concepts designed into the machine were quite attractive, with the promise of faster changeover and an advanced operator interface. Because the technology was new, it was also quite expensive. For that reason, managers selected the smallest model available and planned to run it continuously at top speed.

You may have already guessed what happened next: Soon after the installation, employees were placed on extended shifts, working weekends and holidays to make up for unplanned deviations. The equipment was operating at full tilt, with little time allowed for preventive maintenance. As employees began burning out, the machine was also faltering, with electrical and mechanical failures occurring at increasing rates. When the company's managers asked the machine supplier for help, they learned that the small machine was built for R&D, not production. It took 2 years of overworking the personnel and machine before the company exchanged it for a production-rated and field-tested unit.

A poor choice of machine cost this company business and overtime pay and diminished morale. In hindsight, the managers recognized that they should have given more thought to their needs. All the information was available at the time of purchase, so the stress on the equipment and personnel was completely preventable. The lesson of this story: Fight the urge to make price and availability your first qualifiers for an equipment purchase. Instead, identify the right machine for your application.

Capsule filling methods. There are several ways to fill capsules, and each has unique characteristics. If you fill powders, there are tamping, dosator, and auger machines. Which is right for your application depends on factors such as fill material, desired speed, and versatility. Prior to making a purchase, work with equipment vendors to perform factory tests. Have them run your most challenging products, and observe the tests in person so that you can see which machine works most naturally with your products. For instance, does the machine run immediately within its operating capability or is some tweaking or modification required? Establish a rating system and quantify how easily or well each machine sets up, operates, cleans, and meets quality goals while meeting yield. Some companies prefer to use just one filling technology and one equipment vendor. The benefits of that approach include focused training and equipment knowledge, minimal parts inventory, and similar standard operating procedures. Other companies prefer to use diverse technologies, allowing them to fill a wider variety of products using fewer excipients and with less re-work. When purchasing new equipment, determine whether simplicity or versatility is more important and proceed accordingly.

Selecting vendors. It's no surprise that trust and reputation come into play when considering which equipment and vendor to select. This will become most evident when your new capsule filling machine crashes (and it will). If the spare part you need isn't in your parts kit, how soon can you get it? If the OEM part entails an 8-week wait, is your machine common enough that you can find the part elsewhere? If your machine is a common one, can other people help you? In many cases, it's the capsule shell supplier who provides training, repair, and preventive maintenance assistance.

For those of you seeking a high-tech machine, what happens when there's an electrical problem that your technician can't troubleshoot? Are OEM technicians available by phone to walk you through a troubleshooting solution? What time zone are they in? Do they speak your language fluently? How quickly can they be dispatched to the site, if need be?

Once you have your machine, you should maximize its use (uptime). Doing so is easier when the equipment has the correct capacity. You don't want to jeopardize the well being of your personnel and the equipment, as I described earlier.

Maximizing efficiency. Not every machine is efficient for every job, and a spreadsheet is helpful for maximizing uptime. See Table 1, which lists the average production run size and each machine's hourly capacity at a given capsule size. You will have to project the amount of uptime you get from each machine once production is underway. You must also determine the amount of time required to clean each machine between runs. According to this model, Machine Y would be the best choice since it would require the least amount of time to complete an average run. This and similar models can help you select which size of capsule filler (or other equipment) to use or buy for a particular application.

Designed downtime

Remember Aesop's tale about the goose that laid golden eggs? It tells of a farmer and his wife who, unsatisfied with receiving one golden egg per day, kill the goose to get all the gold they presume must be inside the creature. Instead, they find its insides resemble those of every other goose. They have lost the source of their wealth.

The same greed and shortsightedness are evident at companies that neglect preventive maintenance and necessary repair while seeking higher production. Like the couple, they do not become rich, but rather reduce the daily effectiveness and service life of their equipment. Too many companies do not allocate downtime for maintenance unless the machine breaks down. Such neglect will ultimately cause more unplanned downtime and cost the company more than regular maintenance would. I don't understand this behavior. It's like allowing your car to run out of gas before refueling it.

So plan for maintenance, just as you would for your car or other belongings. You'll optimize machine performance during production and prevent untimely (and costly) shutdowns. If you're not doing this now, here are a few tips to get you started.

Define what maintenance is required and at what intervals. Capsule filling machines have cams, linear ball bushings, shafts, seals, and gears, and each requires inspection and maintenance at scheduled intervals. Some machine areas have high exposure to sticky or damaging products and must be maintained frequently, while others are in sealed locations, requiring less frequent attention.

The equipment manual usually provides maintenance information, but the quality of it varies: Some is very specific, and some is very vague. Many companies rely on their capsule suppliers to help them troubleshoot the equipment. In fact, if you don't have a preventive maintenance program in place, you might turn to your suppliers now to help you establish one. They might even help you perform maintenance the first couple of times.

Prepare a schedule and stick to it. Coordinate the schedules of service technicians and production personnel to find the best times for shutdowns. Do your best to stick to the schedule, but be ready to fine-tune the timing of the maintenance intervals if technicians notice a problem, such as unexpected deterioration of lubricants or a part that is trending toward failure. After performing maintenance, technicians should ensure proper alignments and general performance by running empty capsules on the machine.

Replace worn or damaged parts. This seems to be an obvious recommendation, but many people try to limp along on substandard parts, risking damage to other machine components and an untimely breakdown. As technicians become accustomed to performing preventive maintenance, they'll improve their ability to identify worn and damaged parts. They'll also gain an appreciation for

TABLE 1

Spreadsheet method of selecting the most efficient machine for a job

Average run size	Machine model	Capsules per hour	Uptime	Run time (hours)	Changeover time (hours)	Total hours
253,000	X	40,000	75%	8.43	1.5	9.93
253,000	Y	90,000	87%	3.24	3.0	6.24
253,000	Z	120,000	90%	2.34	5.5	7.84
253,000	ZZ	150,000	90%	1.87	7.9	8.87

how the part or parts affect machine operation. Technicians should periodically measure the bores and pins of expensive tooling to identify wear and report the results to managers well before replacements are needed.

Orchestration

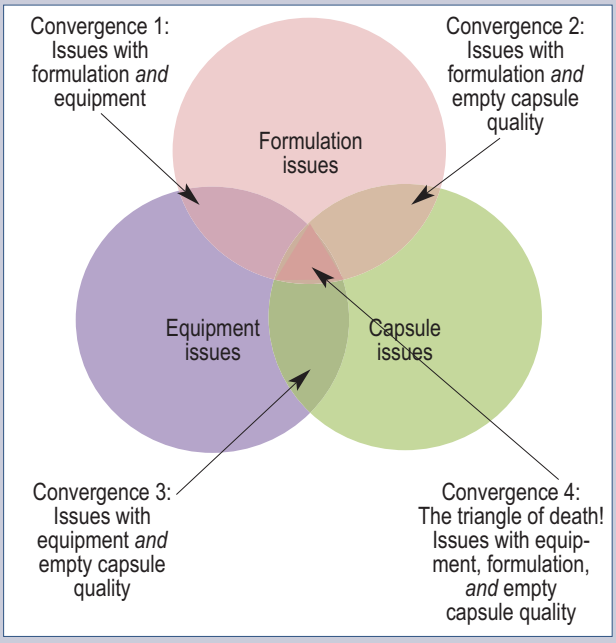
It's understood that each component of the capsule filler, formulation, and empty capsule plays a critical role in final product quality. That simple truth is often overlooked, however, which makes it difficult to unravel when discrete factors combine and present quality defects. The Venn diagram in Figure 1 illustrates the interplay of the major factors that contribute to the potential for failure in your capsule filling operation. As a rookie operator of capsule filling machinery, I recall catching handfuls of capsules as they left the machine and noticing several types of defects occurring simultaneously. To avoid that nightmare, plan ahead:

- Formulators should perform sieve testing and other analyses, such as flowability and compaction behavior, before sending products to operations. When new or problematic products enter the capsule filling area, it's helpful if formulators observe the run so they understand what changes might be needed.
- The job of maintenance technicians is to keep the equipment in top shape at all times. I know a company whose encapsulation department runs eight large automatic filling machines, five of them more than 20 year old. The company runs multiple shifts daily with very little unplanned downtime and produces high-quality filled capsules. That's mainly because the company is committed to equipment care and preventive maintenance. As a result, when troubleshooting is required, operators and formulators can focus on areas other than the machinery.
- High-quality empty capsules are needed for high-quality filled capsules. Whoever buys your empty capsules must choose wisely. With GMP now applicable to dietary-supplement operations, manufacturers have more responsibility for ensuring that their suppliers comply with quality standards. Make sure the capsule supplier provides details about its manufacturing environment and the supply chain.

It's also critical to prove the capsules to see how they perform on your filling equipment. Don't invest in low-cost capsules only to find out that the initial savings are lost in wasted raw materials and downtime. Stick with capsule suppliers who have the experience and expertise to provide consistent quality.

FIGURE 1

These are three main sources of trouble in capsule filling. The less they overlap, the easier it is to resolve problems.



Manufacturing evaluation

Six sigma, lean manufacturing, and other continuous-improvement approaches are unquestionably valuable, but you don't need special training to improve your department. In fact, the best improvements will likely come from operators, technicians, and other department leaders. Take advantage of their knowledge and experience. For instance, have one or more operators observe cleaning and/or changeover operations and record in detail what they see. How much time is taken for different tasks? How could the tasks be done better or faster? Which tasks are unnecessary? One common mistake is not having enough of the correct tools on hand.

Next, be ready to listen. Encourage brainstorming and teamwork. Discourage complaints and negativity. Finally, set goals and reward improvement. Be creative! Maybe you could play chef and cook a meal for your team.

I know a company leader who deputized production employees to be manufacturing engineers in their areas, and they responded, suggesting improvement ideas that were approved, implemented, and applauded. Even if you cannot implement an idea, thank the person who offered it as a way to encourage creative thinking. Employees work better when their bosses recognize and value their work. *T&C*

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