As part of ongoing research into the performance of manufacturing IT investments, AMR Research recently interviewed manufacturers across various industry verticals about the kind of return on investment (ROI) that they were seeing from their manufacturing execution system (MES). Across the board, it was found that MES paid for itself on traditional cost reduction measures within six to 24 months of going live. Returns accrued over the long term, however, far exceeded initial justification hurdles, with some manufacturers seeing returns in the 6x to 10x range per year. Returns of this magnitude, however, aren’t attributed to MES alone. Instead, companies use the visibility that their MES systems provide to make continuous improvements throughout the manufacturing value chain, leveraging the value of product and process information into new revenue opportunities. The message is clear: if you haven’t invested in MES, you should; if you already have MES, you can probably use it to get more recurring benefits.

Research methodology
AMR Research interviewed over 20 companies on their experience in implementing MES. These detailed interviews covered detailed project costs, best practices, and tangible and intangible benefits. The companies included AMR Research clients and references provided by the following MES vendors:

- Apriso
- Aspen Technology
- Camstar
- Datasweep
- GE Fanuc
- Honeywell POMS
- Mountain Systems
- Rockwell Automation
- Siemens
- Visiprise

AMR Research would like to thank the manufacturers and vendors that participated in this study.

With an average payback of 12 months, MES offers even bigger returns for producers that use it to drive continuous improvement. Most manufacturers continue to justify their MES investments on tactical and easily measurable operational cost reduction metrics: labour, inventory measures, lead times, maintenance, data accuracy, and reporting. For many first-time MES buyers, or those replacing homegrown systems, traditional targets for cost reduction are easy to come by and to instrument, and the payback is real. The majority of MES implementations studied paid for themselves within 6 to 24 months of going live, with an average payback in 12 months (see Fig. 1).

- Users saw discernable improvements in quality, starting at the three-month live mark, with reported increases in process yields ranging from 3% to 8% for high-volume discrete manufacturers. Batch producers in food and pharmaceuticals reported first-time increases of up to 30%. Improvements in inventory measures focused on work-in-process (WIP) and finished goods, with one manufacturer saving 52% in WIP within the first six months.
- Manufacturers moving for the first time to automated data collection, electronic work instructions, and e-signature-based review processes generally paid for their implementations outright on head-count reductions alone. Reductions in the time and labor component of data entry, signature review, inventory counts, shift overtime, and root cause failure analysis were unanimously reported. One manufacturer shaved two hours off the batch review process - a significant savings over tens of thousands of batches per year.
- As Fig. 1 shows, less easily quantified but significant (3x and up) benefits result from the cumulative effects of near real-time visibility into the production process.
- Virtually all of our respondents reported dramatic reductions in production reporting latencies (24 hours to byshift granularity and, in one case, weekly to daily).
- MES traceability and genealogy tracking capabilities were cited repeatedly as customer requirements, particularly for manufacturers in complex supply chains.

Fig 1: Benefit recognition timing for MES investments.
For electronic contract manufacturers, these capabilities are marketed to prospects and translate into a competitive edge in a tight market. One electronics manufacturing service reported increases in revenue because of new business opportunities as high as $15-million. Another reported the ability to pursue revenue opportunities in the medical device market—a market whose stringent traceability requirements had previously barred entry.

While few manufacturers justified their MES investments on improvements in the New Product Introduction (NPI) process, a number ultimately found their greatest benefits in that area. One reported a 50% reduction in NPI time based on rapid root-cause failure analysis of producability problems during ramp up and the elimination of rework at the end of the process.

The largest benefits of MES come from leveraging the visibility that MES affords into overarching continuous process improvement and supply chain management strategies. At a fraction of the cost and time of an ERP initiative, an MES platform provides visibility into accurate, high-velocity information about production performance. This enables manufacturers to recognise and then seize new opportunities both internally and in the marketplace.

By extending production visibility throughout the internal supply chain, one manufacturer increased product margins on both higher volumes and higher product mix, all while keeping costs constant. The net effect was to preserve profitability despite lower sales—a universal theme for manufacturers in today’s uncertain economy.

While quick to point out that MES could not be solely credited for performance at this level, manufacturers highlighted its pivotal role in creating an information environment that did the following:

- Support sustainable improvement initiatives by providing continuous performance feedback through real-time information visibility
- Provide the stakeholder visibility needed to manage and streamline the supply chain
- Create a sense of ownership and performance consciousness among operations personnel

Traditional hard savings give a sound basis for the MES business case, but the larger soft benefits are real.

MES attacks a number of easy cost reduction targets. Those reported most frequently as measures used for project justification are shown in Fig. 2, with benefits falling into the ranges reported in Table 1. Ease of measurement was cited repeatedly as a major factor in the particular metrics chosen to develop the MES business case. The larger benefits were universally acknowledged as being real, though difficult to capture credibly in a spreadsheet.

- Classical targets for cost reduction—inventory measures, quality, and labour costs—were cited by most respondents as the measures by which their projects were justified.
- Customer service was a key performance improvement target for the high-volume low-margin manufacturers that we interviewed, which focus on managing late order and partial shipment situations. Though the dollar value was not quantified, one manufacturer reported, “suffice it to say that...”

Table 1: MES benefits: revenue opportunities follow cost reductions.

Table 2: MES project cost breakdown for typical $150M to $500M manufacturing facilities.
customer irritation means lost revenue."

- Reducing the cost of regulatory compliance was a concern almost exclusively limited to medical device manufacturers and food/pharmaceutical manufacturers. For one medical products manufacturer, the integration of MES into weigh/mix operations has eliminated 1.5 million manual entries per year. This same manufacturer has achieved a phenomenal 15 to 1 reduction in the time required to handle a batch exception, on top of a substantial reduction in the total number of exceptions.

- Another major player in the pharmaceutical arena anticipates a combined savings of at least $3-million per year across a number of facilities through a 50% reduction in batches discarded because of processing problems and human error.

MES project justifications did not typically use NPI benefits as metrics (see Fig. 2). However, several of our respondents had altered their business models since deploying MES and were now focusing the technology exclusively on NPI. These manufacturers have chosen to use their MES investments in high-margin product areas while outsourcing low-margin lines to contract manufacturers. Time-to-volume reductions in excess of 50% were the norm for this group. While the cost of man-hours can be measured, the value of decreased time to market for new innovations is priceless.

**System construction accounts for 50% to 80% of total MES project cost**

Depending on the complexity of the installation, first MES implementations (not pilots) for manufacturing units with $150-million to $500-million in revenue fall in the $1.2-million (plus or minus 25%) range. The cost breakdowns for such projects are shown in Table 2. While the “typical” MES implementation is a myth, the percentages shown for hardware, software, and construction costs remain stable across the various industry verticals. The largest variability occurs in the area of system construction, where cost as percentage of the total project can range anywhere from 30% to 80%.

Prospective buyers should budget 60%, taking into account variations based on the following:

- Complexity and availability of interfaces to process equipment and legacy shop floor systems
- Complexity and availability of interfaces to ERP systems - for instance, interfacing to SAP using its proprietary ABAP language can be costly and time-consuming
- Makeup of implementation team (internal resources, professional services, or vendor consultants)

Companies with technically savvy manufacturing IT departments are shying away from external implementation services. Instead, they keep knowledge in-house, retaining primary ownership of the MES application development and deployment process. In this model, key personnel are trained by the vendor and then assume “expert” responsibility within their organisations for ongoing system maintenance and customisation as required.

**MES software licensing varies by vendor and contract structure**

Like anything else, the price of MES software is heavily influenced by the competitive situation and prospect for future business. Economies of scale hold, and large corporate buyers are more likely to garner deep discounts through unlimited use license agreements than midsize companies doing small deployments in one or two facilities.

Here are some recommendations:

- Allocate 30% of your initial project budget for software.
- Seek mutually beneficial partnerships with your vendor and be creative with your negotiations. Goodwill has value, as does the willingness to act as a reference account for the trade press or prospective clients.
- If you are funding development of functionality that your vendor can ultimately resell in the larger market – a frequent theme in MES business relationships – assign a value to your contribution and leverage it into a discount either upfront or on recurring expenses.

**Initial implementations range from 6 to 18 months**

Anticipate 6 to 18 months for a MES implementation. The length of time required depends heavily on the extent of nonproduct features that need to be developed to accommodate the existing production environment. Customisation means more time and higher cost.

- We found that organisations adopting an incremental or phased approach to implementation successfully got their systems operational 50% faster than those opting for perfection on the go-live date.
- Some found ways to shorten the time-to-benefit window by implementing MES functionality in phases or, alternatively, by line or production area.
- Many respondents opted to deploy MES only for new product lines to minimize disruption to mature products approaching the end of their lifecycle.

Recurring expenses are minimal compared to initial project costs, but change always has a cost. As Table 2 shows, recurring expenses are minimal in comparison to initial implementation. In cases where new products are continually being introduced and modifications to the system are frequent, staffing expenses are higher.

For highly regulated industries, the expense of revalidation discourages frequent changes to the installed systems, so staffing expenses are paradoxically lower.

**Rollouts to additional lines or facilities range from 14 to 60 days at a fraction of initial implementation costs**

Manufacturers that rolled out their systems to other lines and/or facilities reported that rollout took an average of 10% of the initial implementation time, at a fraction (25% on average) of the cost:

- One interviewee reported 14 days for each rollout to an additional facility.
- Another was able to get 14 lines up and running in the time budgeted for 7.
- A third reported that since its initial MES implementation, the mandatory corporate payback hurdle for projects had been halved – a reflection of the leaner economy. Would it still be able to justify rolling out the system to additional facilities as originally planned? Absolutely. Achieving the same ROI as the initial implementation at 10% of the time and 20% of the initial cost made additional rollouts a financial no-brainer.

As always in manufacturing, it pays to be pragmatic Don’t sweat the small stuff if cost is a concern - focus instead on reducing time-to-benefits

A handful of MES users completed implementations at costs that were relatively low compared to the overall group of users that we interviewed. These users had done gap analyses between off-the-shelf (OTS) functionality and their perceived requirements,
of 55%), and a subsequently shorter time-to-benefits window.

- Be prepared to seek ways to modify your business processes if you find an MES product that does 80% of what you want out of the box. It's often more cost-effective in the long run for you to institute minor business process changes that shorten the time-to-benefit window than to spend significant time and money upfront on developing and maintaining custom product add-ons.

**Post-facto ROI studies offer insights about the long-term benefits of MES**

Post-facto ROI studies are becoming more common. We spoke to a number of manufacturers that had recently completed some form of benefits analysis on their MES implementations. This practice, while painful, may be necessary to highlight the real nature of MES benefits. All too often, though, projects are completed and metrics supporting the initial business case are forgotten until the belt tightens - as it has over the past three years.

- In the majority of cases, the benefits met or exceeded projected returns.
- One of the respondents reported that it had toned down the calculated ROI because it was too good to be credible.
- Several manufacturers indicated that the cultural changes resulting from visibility into performance were profound. Visibility into performance on a real-time basis had a tendency to enroll operations personnel in the process of continuous improvement with an enthusiasm and sense of ownership that had not previously been sustainable.

**Engage with your MES vendor and fellow customers for mutual wins**

Buyers that adopted this stance rather than maintaining an arms-length relationship with their vendors were able to exert considerable influence on the nature and release dates of product enhancements, mitigating the need to do costly customisation.

It is also important to get to know other users of the product, as they may have insights into areas of benefit that you have not yet considered, and in terms of influencing product development, there's strength in numbers.

**Two heads are better than one - check out ROI tools with potential vendors**

Many MES vendors have decades of combined experience in the manufacturing arena and even offer prefab ROI models. Leverage this expertise to cross-fertilize and broaden your perspective on potential benefits.

**Use professional services judiciously, and look to your MES vendor for expert applications consulting**

Despite a few isolated pockets of expertise, the large consultancies have yet to make significant headway in the manufacturing IT arena, and understandably so. Costly programme management fees make most of the big consulting firms unattractive to margin-conscious producers. Software vendors also offer consulting services, and while comparably priced on an hourly or daily basis, these services embed the kind of product and application know-how that warrants the cost - when used judiciously.

**Closing comments**

In the final analysis, MES offers a wide range of benefits, and users that stop seeking benefits when projected paybacks are met are leaving money on the table. MES is a powerful information tool and a vehicle for business process and cultural change. Seek new ways to leverage the insights it yields, and build on those over time.

Visit www.amresearch.com for the complete article.

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