Tech-Clarity

MES Buyer's Guide: Why, How, and What

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Selecting MES for Success

A Strategic Buying Approach

A Manufacturing Execution System (MES) is a foundation for a manufacturer's digital transformation. MES can deliver enormous benefits… if expectations and fit are right. Selecting MES well is strategic and more challenging than many other software applications because production processes and problems vary widely. They also change regularly. This Buyer's Guide will help you select a system to guide, track, and manage manufacturing in a way that delivers benefits to the many stakeholders and the company immediately and over the longer term. The three sections focus on why it makes sense to adopt MES, how to craft the buying process appropriately, and what evaluation criteria to use.

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Executive Summary

MES is Strategic

MES has increased in importance with Industry 4.0 and Digital Transformation. Manufacturing data is central to the information flows that can optimize business success. Thus, manufacturers should regard buying MES as a strategic project. This decision is a cornerstone to enable digital continuity for production plus the rest of the enterprise.

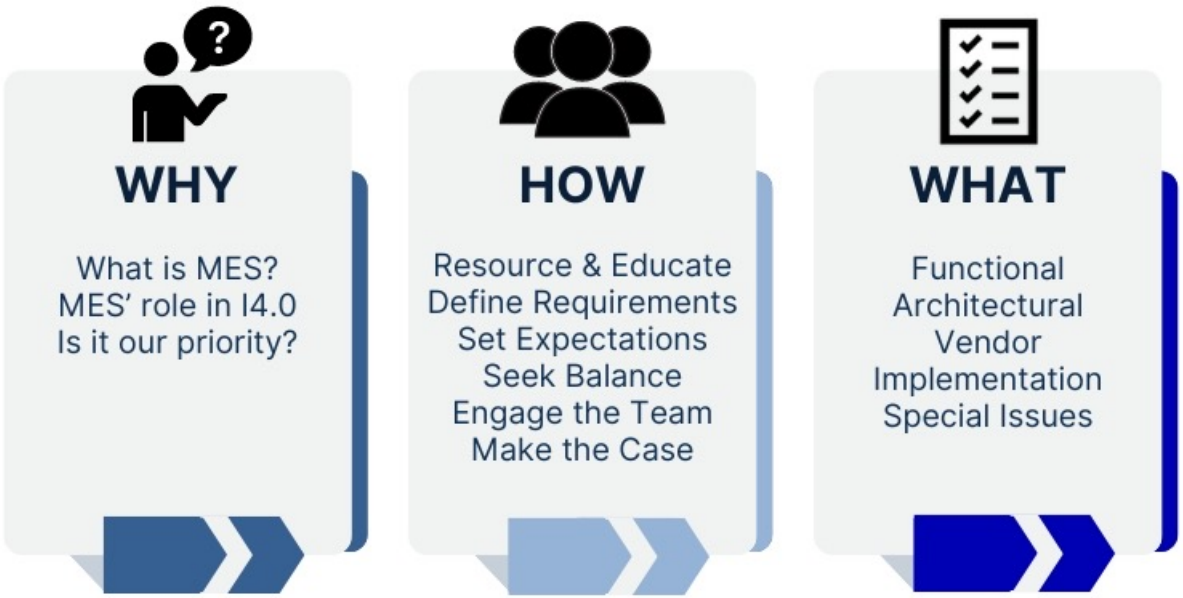
Why this Guide

Each manufacturer needs to address arguments and misconceptions about MES. This guide offers ideas about three main areas where MES buying projects often go wrong. There is a section for each of these areas.

Why MES Matters

The first step is defining MES and explaining why it's vital to the company's success. Without some education, many manufacturing companies' teams can't agree on their needs and why they should invest in MES. This guide points to the role and benefits of MES in the manufacturing application landscape.

THREE SECTIONS OF THIS GUIDE: WHY, HOW, AND WHAT TO EVALUATE IN MES



How to Buy MES

Organizing your team and the buying process for success may sound straightforward, but it is not. MES has many stakeholders and specific issues that are not common to other enterprise applications. Standard software procurement processes often fail to select the best MES for a manufacturer's situation.

What to Consider

The third section focuses on what to evaluate when considering your MES options. Categories of criteria include product functionality, technical architecture, vendor, implementation, and special needs you may have.

Why: Manufacturing is Your Business

RANKING OF KPIS AMONG BEST-IN-CLASS MANUFACTURERS

1. KPI Product Quality
2. KPI Asset and Equipment Efficiency

What's the Business

Manufacturing companies make money by converting lower-value materials into higher-value goods. It's what they're in business to do, so this conversion process is central to the company's value and differentiation. For many companies, this has not been where they've focused on digital transformation, but that's changing as competition ramps up and digital ways of working improve.

Key Performance Metrics

You measure what matters. As the INCIT research shows, the top two KPIs for best-in-class manufacturers are product quality and asset and equipment efficiency[1]. Small and mid-market manufacturers share these priorities. These KPI targets are met (or not) on the plant floor.

Manufacturing Costs

Manufacturing costs may be a substantial portion of overall business costs. These include direct and indirect materials and labor, utilities, procurement, shipping, duties, and factory overheads such as property tax, insurance, and maintenance. For many companies, these are half or more of their costs. So, saving even a tiny percentage of that cost can directly impact profitability.

Faster Decisions on Value-Add

MES is the foundation that delivers information to make better, faster business decisions in the plant. Modern systems can also enable information comparisons and KPIs across many manufacturing facilities. Because MES transforms diverse plant data into information, it also serves decisions across the business and its customers, suppliers, and partners.

Source: International Centre for Industrial Transformation (INCIT) data cited in World Economic Forum

Why: MES and Other Digital Transformation Projects

Plant Data is Central

MES is often a top priority among the many technology projects a company could undertake. That's because plant floor data in context – across one or many plants – is vital to the entire business: finance, design, supply chain, quality, regulatory, and profitability. MES is uniquely designed to handle the diversity of data in production. No other system aims to do this.

Diverse Data

Manufacturing data comes in many formats, volumes, and frequencies, including relational database or structured data as well as unstructured documents. The plant also has tag, point, and time-series data from process, line, utility, and facility control systems.

With the advent of the industrial Internet of Things (IIoT), more data is coming from the production process and equipment. All of this data is only valuable if you can put it in context and know what to do with it.

IT/OT Converges Here

One of the thorniest issues for Industry 4.0 has been harmonizing information technology (IT) with automation or operations technology (OT). Our research shows that nearly 40% of companies often have conflicting data between IT and OT systems.[2] Modern MES is designed to bridge the gap, create better understanding, and ensure good performance.

Workforce Needs

The shortage of personnel to work in manufacturing, particularly in production operations, affects most manufacturers. MES is a way to provide workforce support in an environment with rapidly changing processes and often high turnover. MES can ideally support digital-native younger workers and those with vision issues, varying native languages, and others.

MAKE IS THE CENTER OF THE PRODUCT LIFECYCLE, SUPPLY CHAIN, AND DATA FLOW

Why: Manufacturing Software Frameworks and Terms

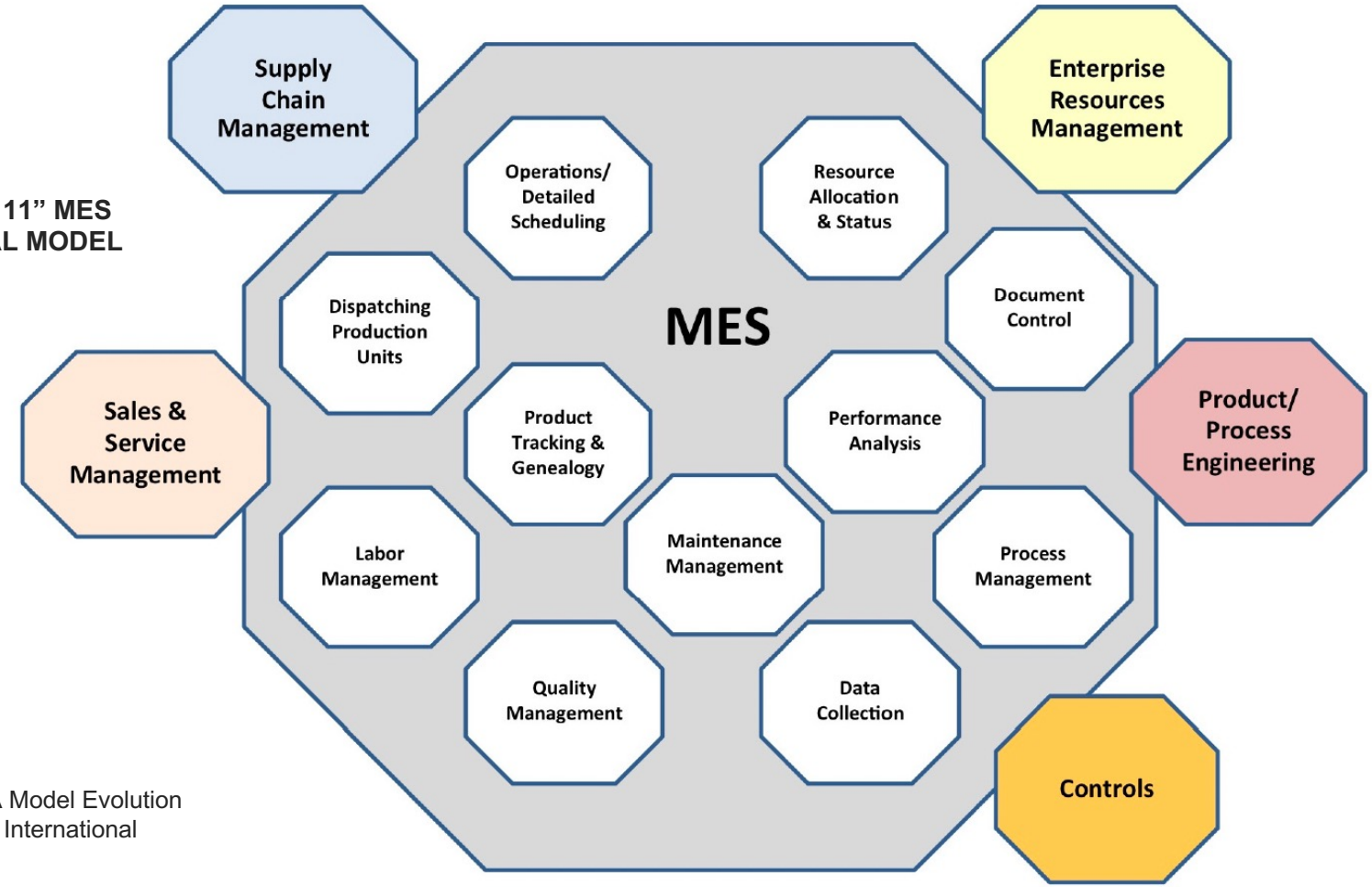
MESA Model

In 1992, MESA International was formed to educate the market about MES. The association published a paper with MES functionalities, models, and relationships to other technologies. This original model defines 11 MES functions, which are still relevant today.[3] The 2002 MESA Collaborative MES model defined an eight-function scope to reflect what MES delivered at the time.

MES Expanded

While some MES products are more limited, some deliver the 11 functions, and some have expanded beyond those capabilities. Some systems now include a platform for industrial internet of things (IIoT), analytics far beyond reports and KPIs, a digital twin of plant status, and more.

THE "MESA 11" MES FUNCTIONAL MODEL FROM 1996



Source: MESA Model Evolution

Why: Manufacturing Software Frameworks and Terms

Tech-Clarity defines **Manufacturing Execution Systems (MES)** as systems that deliver information to optimize production activities from order launch to finished goods. MES guides, initiates, responds to, and reports on plant activities as they occur. To do so, MES puts into context a wide array of real-time and historical data from both operations technology (OT) and information technology (IT). MES can deliver mission-critical information about production activities to the rest of the product lifecycle, enterprise, and supply chain via bi-directional communications. MES often includes adjacent functions such as quality, scheduling, in-house logistics, and asset maintenance, which comprise Manufacturing Operations Management (MOM), as the ISA-95 Model envisions.

ISA 95 Layer 3

In 2000, ISA published the ISA95 Enterprise-Control System Integration standard.[4] This framework defines levels, where

0 is the process

1 is equipment and automation

2 is SCADA and related control software

3 is manufacturing operations management (MOM)

4 is enterprise systems.

MOM includes production, maintenance, quality, and inventory. Some prefer the term MOM to MES, but the difference in scope is mainly historical. How a company refers to its product may or may not indicate breadth.

Considerations by Industry

MES applies in any manufacturing environment, but there are nuances for batch vs. continuous vs. discrete vs. assembly and automated vs. manual. It's crucial to seek out software that matches the manufacturing mode and specifics of the processes it will support. There are typically fewer MES options for mixed-mode industries with more than one type of production.

Why: Evidence of MES Value

MES Adoption Growing

Despite many new plant floor application types, manufacturers continue to adopt MES. Recent market research indicates a compound annual growth rate (CAGR) between 9% and 13%.[5] LNS indicates that MES adoption doubled between 2019 and 2023.[6]

MES Value for Decades

MES manages the plant floor and puts its data into context. Many case studies describe the improvements manufacturers make using MES on both operational and business KPIs. Older research has already shown this. For example, MESA/Gartner's research from 2019[7] shows that MES starts to deliver benefits in under three months.

Software Buy vs. Build

Manufacturers with simple processes face a build vs. buy decision for MES. Other options include integrating point solutions or using all low-code. However, the user-facing applications these can replace are only part of MES' value. MES also enriches manufacturing IT and OT data and feeds in-context information to the enterprise and ecosystem. A complete modern commercial MES is the most efficient way to create actionable information flows.

Implementing for Value

LNS research shows that the top operational challenge is a lack of collaboration across different departments. MES can deliver consistent production information to encourage trust and collaboration.[8] Yet, not everyone succeeds with MES. In our research, Top Performers have better MES success than others.[9] Most top performers agree their MES creates high value for resources expended and streamlines work for frontline workers.

MES PERCEPTION DIFFERENCES:
TOP PERFORMERS VS. OTHERS

How: Ensure Resources and Education

Multiple Stakeholders

MES touches many departments and roles—all must be involved. Manufacturing operations are typically the primary owner, but production engineering, IT, quality, scheduling, materials management, maintenance, and business executives all gain visibility. All are involved in the buying process and aligned on goals for the best results.

Educate on Why and What to Expect

Educating the entire organization on "Why MES" for your company can be crucial to success. Many people will have an opportunity to block or slow the project, so helping them see what's in it for them helps. Beyond buy-in, it's also important to set expectations. We recommend educating a core team on what to expect in MES. A great way to do that is through the MESA International Global Education Program MES/MOM certificate courses for program executives (CoA) and project technical team members (CoC).[10]

Open-Minded Approach

One of the challenges with so many stakeholders is for everyone to remain open-minded. You do want experienced people on the MES project team. However, people must not rely on past software projects or MES experience. Why? Because you don't know what you don't know. Today's MES products and your needs are different – and tomorrow's will be as well. Every manufacturing company and plant is different. Thus, neither your people nor the vendors will know everything before the implementation begins.

How: Ask Good Requirement Questions

KEY LESSON

Get what you need, not just what you know to ask for – by leaving the RFI open for creative responses from the solution providers. **You don't know what you don't know.**

Listen and Learn

Sending out requests for information (RFIs) is an opportunity to listen to software providers and learn from their years of experience. Yet, they often do the opposite: they push the vendor into checking boxes that may obscure their strengths and differences.

Requirements hat Work

Be sure the request explains your situation and goals clearly, including your business objectives and priorities, targets for improvement, and obstacles or issues. Requirements are your needs to improve performance and gain business value. These are requirements for *what* the software does, not *how*.

What You Need, Not How to Do It

Know what you need to accomplish for the MES implementation to be considered successful.

Put that into the RFI. The trick is not to dictate how the software will do it. That limits the value you get from this exercise. Your job is to stay focused on explaining your company's requirements and situation. Each software provider's job is to evaluate and then explain how they will meet your needs

Key Lesson

Get what you need, not just what you know to ask for – by leaving the RFI open for creative responses from the solution providers. You don't know what you don't know. So, tell the prospective solution providers what you do know, and let them tell you what they know. They have seen many companies and may have valuable points of view to share. The open exchange of information is crucial to an effective buying process.

How: Set Realistic Expectations for MES

Involve Many from the Outset

MES is a complex, multi-function software solution like other enterprise applications such as ERP or PLM. It will deliver critical information not just to plant operators and technicians, but to various people across the company. Stakeholders in many disciplines and various levels are ideally involved from the beginning of the buying process.

Expect Change

Even preparing to buy MES can be transformative. Groundwork includes describing as-is bills of materials, operating procedures, and routings. In this process, companies often realize their understanding of processes and operations data is not complete. To get full benefit, expect to change things to optimize not only the MES' use but also the manufacturing operation itself. Expectations may change as you learn.

MES for Digital Thread

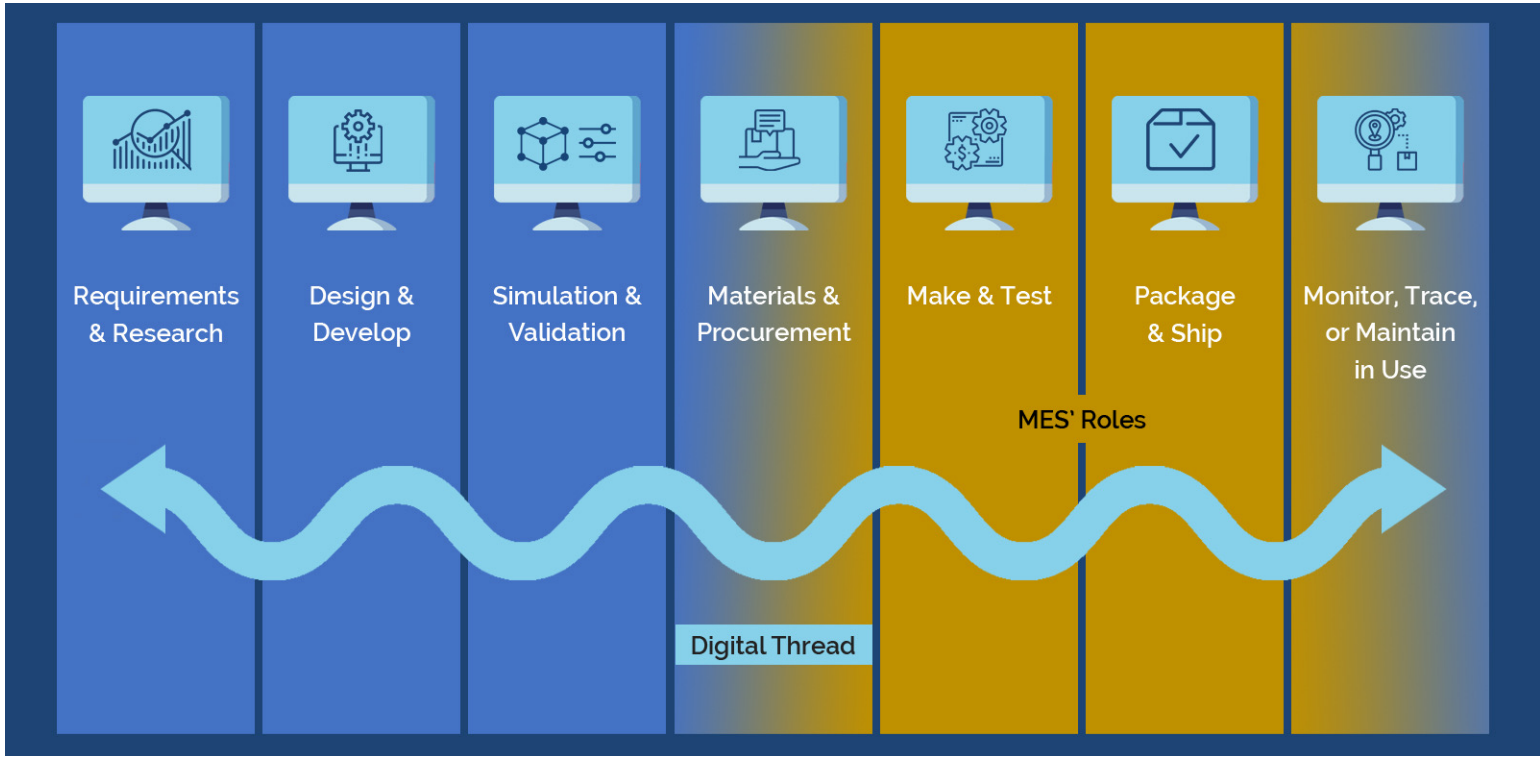
One clear need is for plant information to feed the enterprise or digital thread in a timely manner. So, MES must interoperate with other enterprise applications. A new MES may have better or different ways to share information, and the need for current data everywhere is more urgent than ever with traceability, compliance, and sustainability expectations.

Fitting to Production Realities

MES must be able to mirror the nuances of varied production processes. These production processes are not standard like accounting, design, or quality functions can be.

So, strive to standardize, but realize there is a limit to how much you can. Even if you start with some standards, the processes and best practices will change over time. So, seek flexibility and configurability to meet your needs with minimum customization.

MES ROLES IN THE DIGITAL THREAD ARE IN MAKE AND BEYOND INTO MATERIALS, PACKAGING AND SHIPPING, AND IN USE



How: Learn-as-You-Go

Be Flexible

You and the solution provider(s) will learn as you go. They may know the product, but every business has many nuances for MES to address. Learn-as-you-go means several crucial things that may "break the mold" for your software procurement processes.

Speed and Hardware

Many companies have a clear view of how they want to deploy MES software: on-prem, in the cloud, or a hybrid with edge. Each has its own considerations. Even with that decision, not all performance and hardware needs can be determined upfront. The final model you deploy will dictate what hardware to use to get the performance your business needs. Trust that the software provider can likely accommodate your performance needs if you find satisfied customers. However, the hardware details may only be clear later in the process.

Timelines

Timelines will not be firm and fixed. Increasingly, software projects use an agile approach to try something, learn, and revise to fit needs best. Agile inherently has some timing uncertainty. Yet, it's crucial to MES success since waterfall only goes so far in getting it right. So, milestones for testing and go-live may not be set too far in advance or may move around if you set them earlier.

Price

Do not expect a fixed-price project for MES. You will need to get underway to understand the costs. As mentioned above, your final model will dictate the hardware and network needs. The support you need from a service partner will also make a difference.

How: Take a Balanced Approach

Long-term Partner

Selecting MES is the start of a strategic, long-term partnership. It's essential to treat it with the care and long-term vision you would have when choosing a life partner. The goal is to be empowered by this partnership. Ideally, both your company and the software provider will keep evolving the MES in the future. (See p. 20 for more on this.)

Tailorable Application

You want the benefits of standard commercial off-the-shelf software (COTS) configured for your unique needs in an easily upgraded way. This means MES should not be a turnkey system, a pure DIY low-code toolkit, or a highly customized version of standard software. Seek out those touting configurability and composability.

Co-innovation

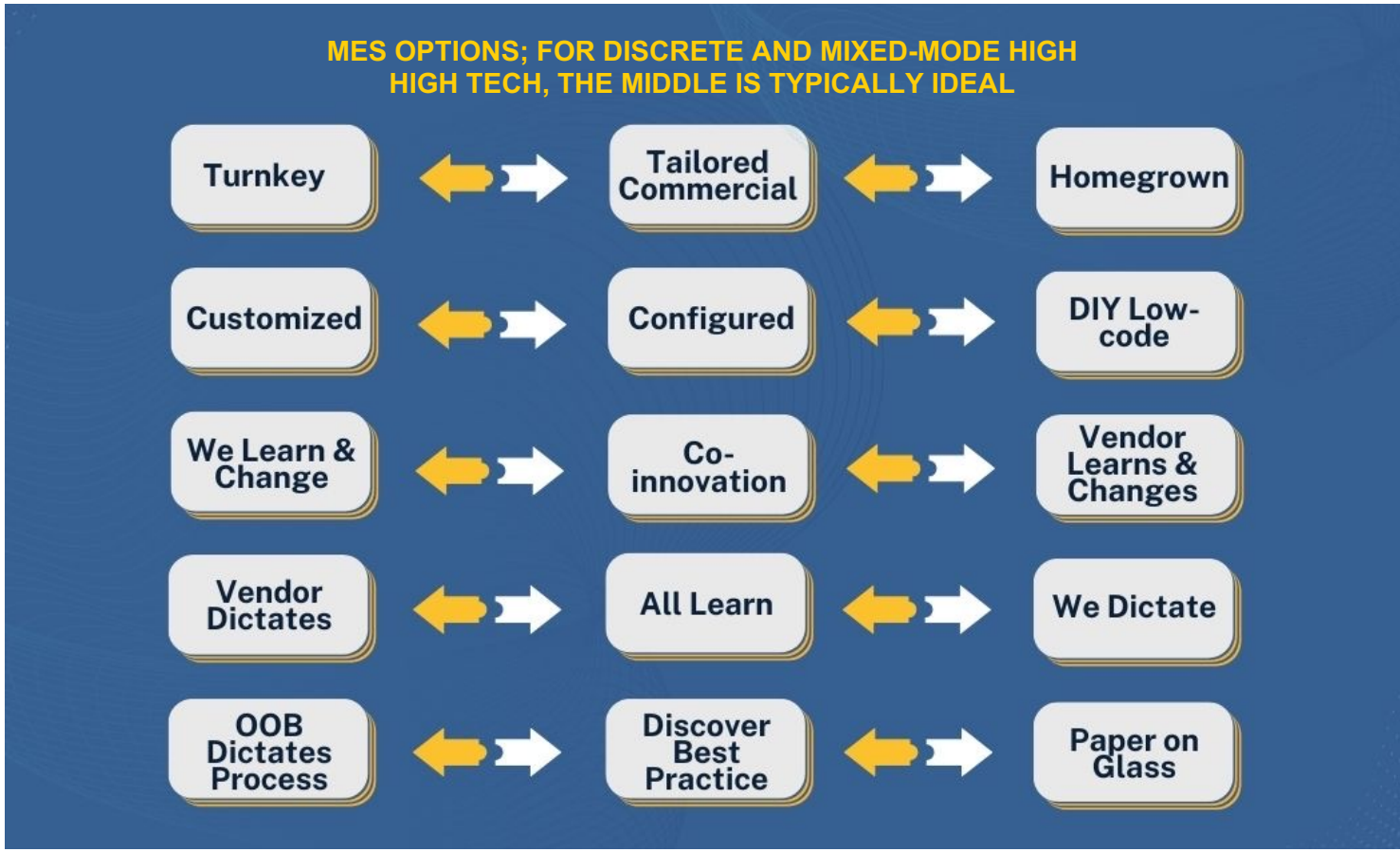
MES should be a collaborative and innovative venture. Leverage your team's expertise in your unique processes and needs. Leverage the knowledge built into the software; it may streamline your processes.

Ask the MES and service providers' opinions; they have many experiences. Often, the solution provider will have better ideas than you could imagine.

Change Management

MES is often part of a digital transformation, meaning you must expect and push for change.

Yet you do want to leverage best practices and internal experts. Finding a balance between your current best practices and the best practices built into the software is crucial. You ideally learn from each other – and find a software partner who has proven that they listen to customers.



How: Engage in the Buying Process

Open Process

A buying process should help you learn new things and facilitate change. This indicates an open process. We do not recommend a predefined list of software requirements that close off options for how the system should operate. Requirements are what you need to get from a system, not how it does that.

Core Team

Recruit the best people with technical and production process domain expertise for the MES team. Start by establishing ground rules and getting everyone ready to collaborate. Collaboration does NOT mean everyone is aligned from the beginning. It is healthy to have some likely skeptics on the team. The team should have representatives from all levels, from executives to steer, to plant leaders, to engineers, to associates on the floor.

Led by Operations

Experience shows that those who stand to gain the most and will be primary users are ideal project owners. Thus, Operations should lead the project, not IT or purchasing. The manufacturing team members know the manufacturing processes and problems to solve.

Communication is Crucial

The team must work together and communicate openly and respectfully. Remember to establish ongoing communication between the core team and other stakeholders, both internal and partners. Expect to spend several months corresponding with solution providers. This should enable you to deliver enough information to understand your needs and for them to provide complete information for your decision.

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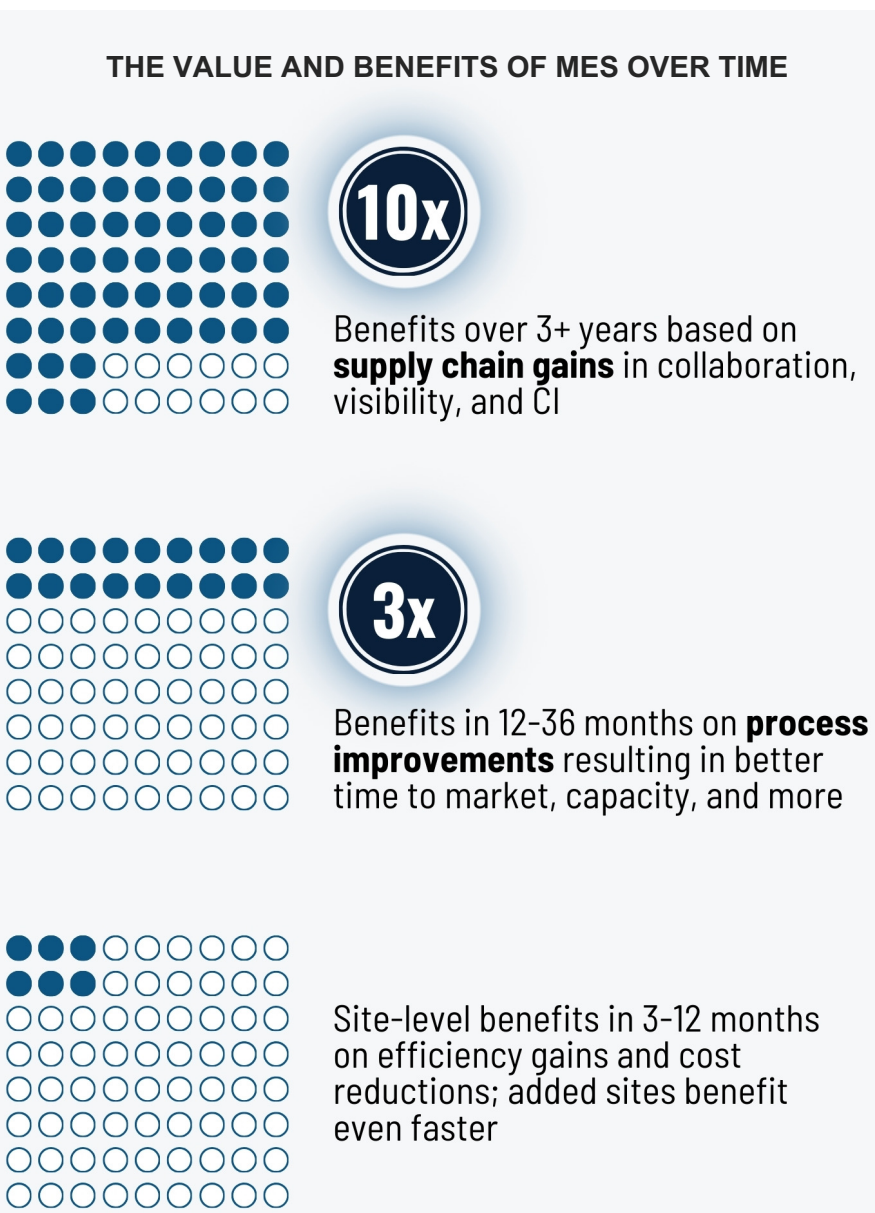
How: Crafting Business Case and ROI



What You Don't Know

You won't know all the costs or all the benefits of MES upfront. This requires exploration, conversations, and investing and starting the project. Yet, you typically need to make the business case to get the funding. Showing a return on investment (ROI) by listing all the benefits and costs in at least approximate numbers is usually required to compete for budget. As mentioned above, you may have a ballpark price but do not expect an exact figure when signing the contract.

Making the Business Case

Educate yourself to justify the MES purchase. Learn what the corporate strategy is and align your benefits to that. Then, work to set your improvement targets to show benefits. Remember the "soft" benefits you cannot quantify; often, these also align with some strategic objectives. At the same time, reach out to solution and service providers to begin to scope the project and its costs.

Learning Resources

Many manufacturing professionals are not proficient at justifying their projects and getting budgets. Learn how to make a powerful business case. The MESA Smart Manufacturing Justification and ROI Guidebook[11] and ROI and Justification Course[12] are great resources for learning the angles on both the cost and benefit sides. You will need to do the work, but these provide the framework for a solid presentation to get budget.

Enlist Support

MES can deliver benefits that improve both top-line and bottom-line results. It also delivers strategic benefits that are difficult to measure, or "soft." Yet budget competition is typically fierce. So, ask your finance and accounting team to support you. If top executives want to succeed with digital transformation, enlisting even one of them can also turn the tide toward approval for MES.

Source: MESA Smart Manufacturing Justification and ROI for MES Guidebook, © 2014 MESA International

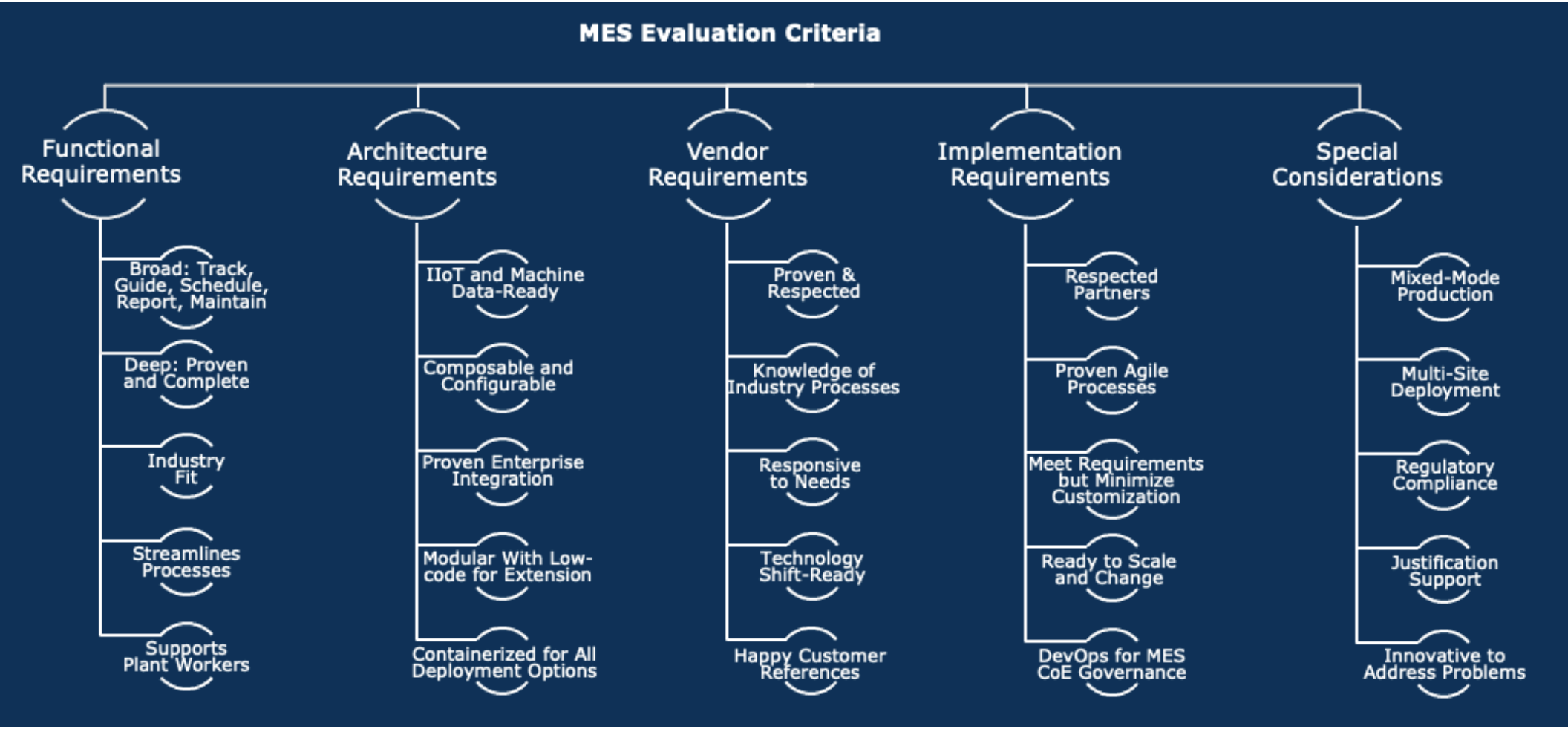
What: Buying Criteria

Evaluating MES

There are many MES options available. This section of the Buyer's Guide is Tech-Clarity's structured approach to helping you identify critical evaluation criteria. These include functional and IT architecture aspects of the software, the vendor, implementation, and special considerations that may not apply to every manufacturer's situation.

Not Primarily Cost

Naturally, cost will enter the equation, but it should not be a driving factor initially for a few reasons. First, this is a long-term strategic investment in the company's data infrastructure as well as plant floor applications. Second, lower-cost solutions may not meet those long-term needs. You need the best fit for your business.



What: Functional Requirements

Solution Breadth

Most companies making high tech products need more than core genealogy, operations guidance, and reporting. It's more the scope of MOM. Level 3 of the ISA 95 model includes quality, scheduling, maintenance, and production. MES may have dozens of modules. Given variety and change in plants, breadth is highly beneficial. It allows a simple start and path to expand.

Depth

Every plant deserves proven and complete capabilities. Industry expertise matters. How deep you need genealogy or traceability to be varies. If you are in a regulated industry or a final product OEM, this may be far more complex than for a parts supplier. A checklist cannot show the depth of MES functionality.

Streamline Processes

Ideally, MES improves the process for operators, technicians, supervisors, and plant managers. We warn against using your current processes as the structure for your MES (often called paper-on-glass), as it limits benefits to slight improvements. Yet, changing processes (even to streamline them) creates a challenge. Ease change management by making it a joint learning process and working with a services provider.

Support for Plant Workers

MES is ideally the system for "connected frontline workers." While a new category that is not full MES has emerged, the best modern MES can do both. MES has always proven to reduce classroom training time, reduce errors, and improve employee confidence.

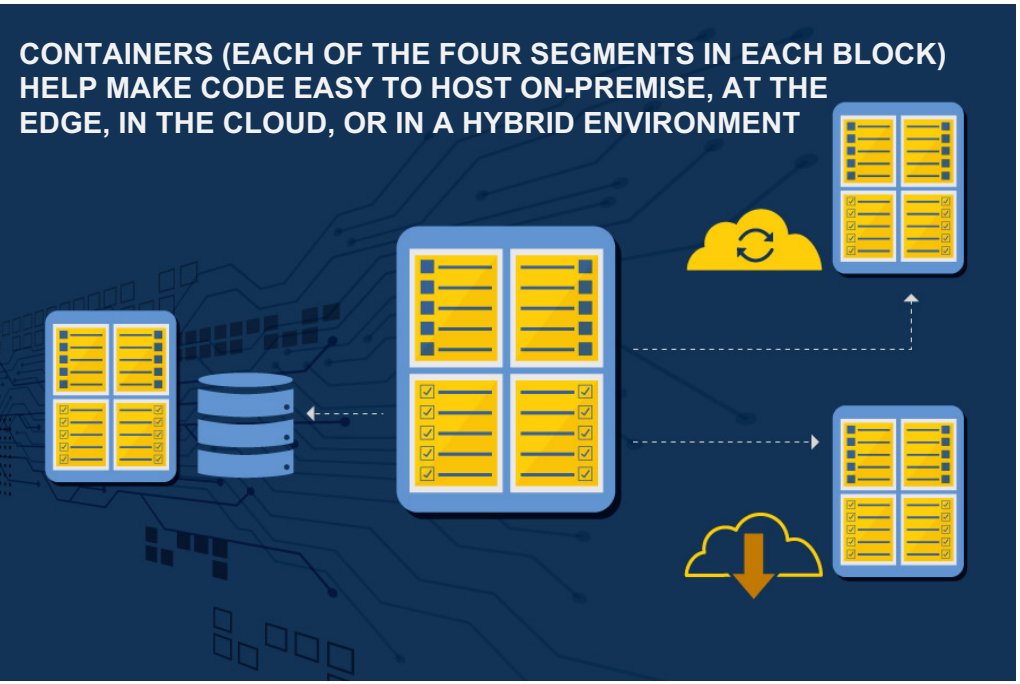
What: Architectural Requirements

Information Needs

Modern IT architectures are crucial for MES. Why? They enable production operations to gather complete data, share it with the rest of the company and ecosystem, keep up with production changes, and move production information as needed. Fortunately, many new factors[12] help enable all of that.

Complete Manufacturing Data Stack

MES today can include a complete IT/OT manufacturing data management and analytics stack. Plant and IoT data are exceptionally diverse and challenging to manage, and MES is a logical home for such specialized capabilities.



Composable and Configurable

MES needs to be ready to change. Configurability enables tailoring of a standard product that does not require custom coding. Composability is a newer concept that focuses on reusable building blocks you can structure and restructure over time as needed.

Proven Enterprise Integration

MES is central to the digital thread through the product lifecycle, the supply chain, and materials flow. So, MES must have reliable enterprise integration to get manufacturing data flowing to ERP, PLM, SCM, and CRM.

Proven IoT and Equipment Integration

To get the benefits of an I4.0 transformation, getting IoT and machine data with context is crucial. The right MES can provide that, with its complete view of operational details.

Low-Code for Extension

Low code enables rapid change by people who are engineers and domain experts. So, while the MES ideally provides most of what you want in a way you can use it out of the box, tailoring is possible with low code.

Containerized for Hosting Options

Like a shipping container, a container prepares software modules for deployment anywhere. Containerization enables all deployment options: on-prem, cloud, or hybrid with no virtual machine.[13] Rather than being a cloud-based or on-prem solution, a containerized solution delivers options for when and how to use each hosting option as your needs vary.

What: Vendor Requirements

Proven

Seek out a respected MES provider. Ideally, the choice is not about the size or political connections of the executives but about customer results and feedback. The operating team will use it, and they need to feel confident that it's the best for them.

Industry-savvy

The software provider must know industry processes. MES is not a generic application; if the solution provider (software and services) has not addressed your industry or issues similar to the ones you seek to solve, you will need to educate them. Decide whether it is worth the effort.

Long-term Partner

The software and services providers must be responsive to your needs now and in the future. Ideally, this does not rest on just one or two contact people but on the company mindset and culture. Part of this is finding a software partner ready to change their software as new technologies mature and new needs arise.

Happy Customers

Speaking with customer references is crucial. However, note that reference calls are a later step. Your conversations with the software provider should be far enough along that they can match you with companies that share some of your issues, outlooks, and preferences. Do not insist on seeing direct competitors who may not have the same MES approach and may not be as willing to share.

What: Implementation Decisions

Respected Partners

Deep and broad software tends to need expertise beyond a single software company. In these cases, an MES implementation works best with a software provider and one of their certified services partners.

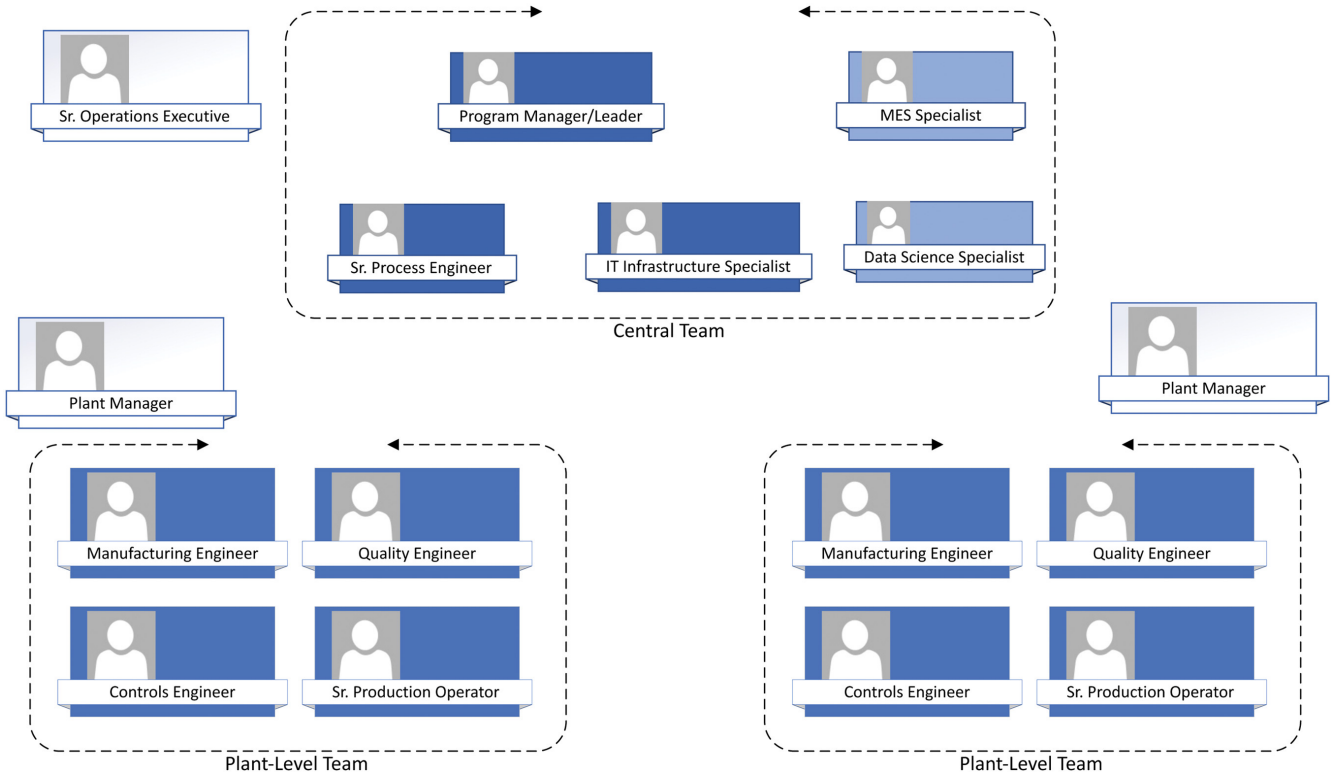
Rapid Learning

The MES project will change as you learn the software and the providers understand your needs. We recommend agile approaches to try things out and change them if needed. Agile sprints are a great way to involve eventual users and get them on board.

Tailored

Ideally, MES is not heavily customized, but also not all cookie-cutter standardized since every plant has some special needs and best practices. MES that can be shaped to fit specific needs yet enable upgrades even to specialized pieces is a foundation for success.

EXAMPLE OF INITIAL CENTER OF EXCELLENCE (COE) STRUCTURE (CENTRAL AND PLANT-LEVEL TEAMS)



Source: Grant Vokey, CoE: The Key to Data-Driven Manufacturing ©2023 ISA

Change-ready

Your business is not static, and the MES must be able to keep up with that ongoing change. We talked about low code and composability. Scalability involves both architectural and implementation considerations.

Rollout Support

Centralized deployment may be attractive if your company has more than one production facility. Seek out MES that has DevOps support for modeling and maintaining templates. Larger companies should consider an MES Center of Excellence (CoE) to oversee enterprisewide deployment. The ISA book on this topic is an excellent resource.[14]

What: Special Considerations

Industry Fit

MES is different from most other enterprise software in that it must fit the specifics of your industry and the types of production processes in your plants. Look for industry fit in software, team expertise, and understanding of your operations. Often a blend of software company and service provider can deliver the deepest industry expertise.

Mixed-mode Production

MES is often best in specific types of processes. If you have some combination of process, batch, discrete, assembly, and recursive processes, you must find a specialized system to accommodate that.

Multi-site Deployment

If you plan to implement MES as a standard in multiple production plants, DevOps capabilities to support a CoE can be necessary.

Consider the solution provider's expertise and their partners in global regions to support your production facilities.

Regulatory Compliance

Heavily regulated industries, such as medical devices, have special needs for documenting products and processes. The solution must support that, as well as your ability to validate the processes it supports.

Replacing End-of-Life

If you currently have an older MES that will no longer be supported, you face a difficult decision. Maintaining software when the vendor does not is expensive and high-risk. To avoid repeating that situation, you need to seek a system with an active roadmap.

Recommendations

Buying for Long-term Success with MES

- MES is a foundation for manufacturing digital transformation and Industry 4.0. Treat it as a strategic move to buy and implement.
- Create a learning, collaborative, multi-discipline team to explore your options for MES to manage your production operation and its data.
- Be sure you and your team thoroughly understand MES, both what it is and does, and why it matters or how you expect it to meet your specific business needs.
- Leverage your team's expertise on the process, challenges, and objectives. These are your requirements – what you need to do, not how.
- Take advantage of the vendor's and implementation partners' knowledge of software functionality and proven project methodologies.
- Do not prioritize one viewpoint over others; all are crucial to success.
- Evaluate not only the software functionality but also its architecture.
- Consider the software provider, partners, other implementation support, and any special needs you have.
- Buying MES should be a learning experience for all. Even with MES experience, it is best to use a "beginner's mind" about how it will solve problems.
- To reap benefits across the business, invest in MES continually and expand how you use its data.

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Acknowledgments

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About the Author

Julie Fraser joined Tech-Clarity in 2020 and has over 35 years of experience in the manufacturing software industry. She is an enthusiastic researcher, author, and speaker. She has a passion for manufacturing progress and performance gains through Industry 4.0 strategies and supporting software technology.

Julie is actively researching the impact of digital transformation and technology convergence in the manufacturing industries, with a focus on supply chain and plant floor and how to use manufacturing data in conjunction with data from offices, labs, and the ecosystem.

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