Digital Transformation: Maintaining the "Golden" Triangle in Large Steel MES Program

Abstract

Digital transformation (DX) is not a new phenomenon in the manufacturing industry, including the metals and steel industry. Yet DX success eludes many. About 70% of all digital initiatives do not achieve their goals.[1] A recent survey of directors, CEOs, and senior executives found that DX risk is their number one concern in 2019.[2]

While Manufacturing Execution Systems (MES) have traditionally focused on maintaining the golden traditional triangle of timeline, cost, and quality using one-size-fits-all solutions, digital disruption is forcing manufacturing leaders to change their project management approach. They must now balance the golden triangle with evolving stakeholder expectations to ensure successful outcomes in line with Business 4.0™ and Workforce 4.0 concepts.

Manufacturers must leverage a judicious mix of emerging technologies such as cloud services, 3D experience, chatbots and others with agility, while maintaining the traditional wisdom of the golden triangle.

This paper explores the need to reorganize traditional project management approaches in the era of Business 4.0 and Workforce 4.0, with emphasis on the importance of having client specific customized standards, based on applicable domain industry standards, best practices and lessons learnt over the period. It details the ways modernization of quality assurance approach supported by the right technologies can help cut costs and accelerate time-to-market.

The Porter's Value Chain Remodeled

The nature of manufacturing execution systems for any domain is closely associated with its value chain. In order to understand the value chain in the metals business, let's look at (figure 1) the Porter's model for value chain in metal industry:

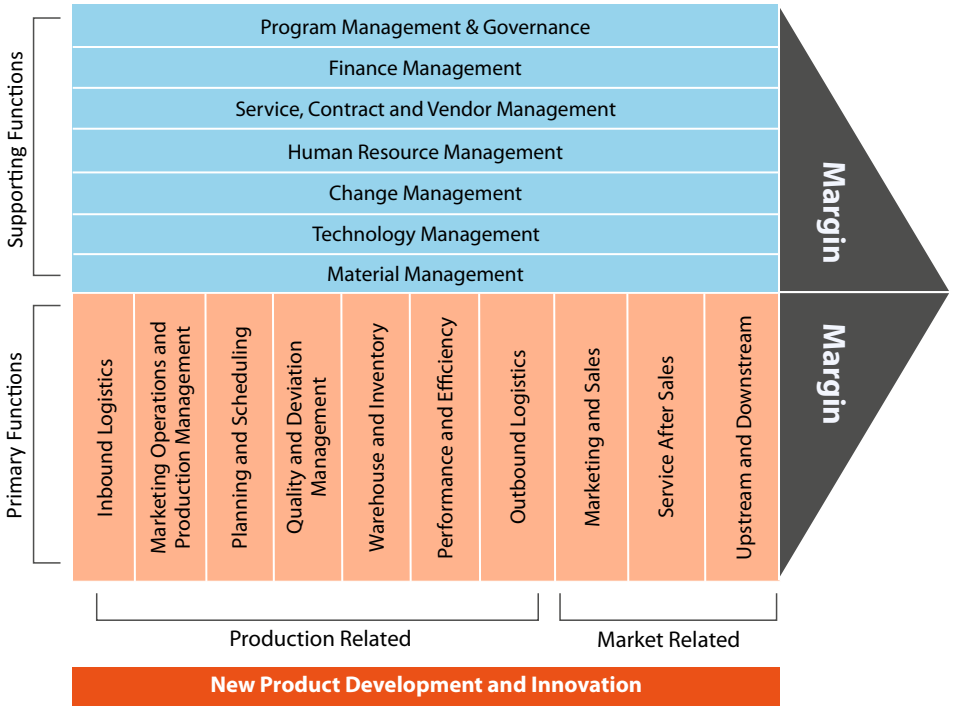

Figure 1: Porter's Value Chain Model Modified

The 'spend' is predominant for production related primary functions than the supporting functions. Now let's look at (Mind map in figure 2) the critical factors to maintaining three corners of the "Golden Triangle" in this industry – Cost, Timeline and Quality.

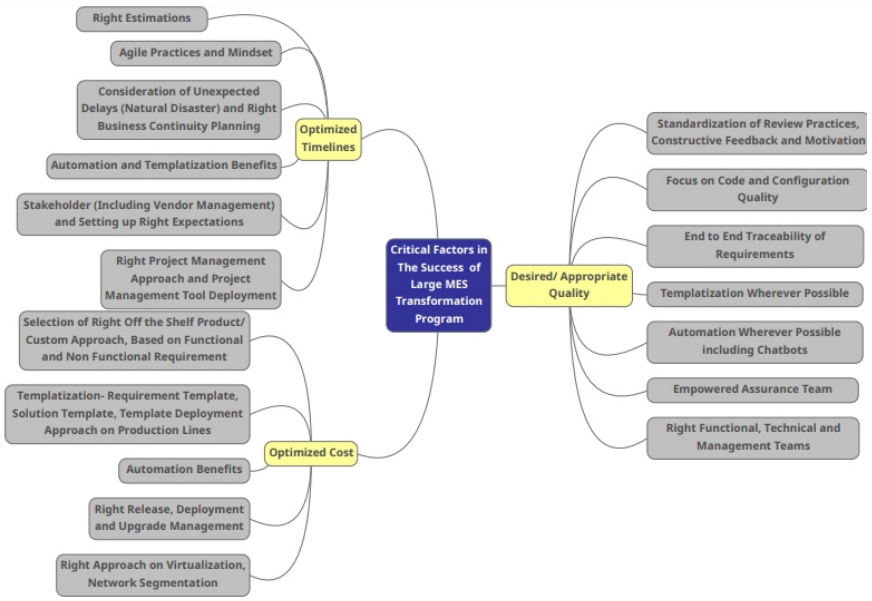

Figure 2: Mind Map for Critical Success Factors

Decoding the Golden Triangle for MES transformations

MES programs are designed to coordinate every aspect of the operation in metal and steel manufacturing – from order release to shipping, with the overall goal being quality improvement, productivity, compliance, and flexibility. Here's how the right approach to MES can add value along the three dimensions of the golden triangle – timeline, cost and quality:

#1 Timeline

Key parameters to ensure adherence to timelines include:

a) Right effort estimation i.e. the estimation of appropriate lead time for setting up infrastructure (including hardware, software, network and development center), hiring resources with right competencies, aligning vendors, and gathering responses from various stakeholders.

b) Agile practices and mindset cultivation should be used whenever possible. Requirement phase may work with hybrid method, considering scale and the interconnected nature of MES. SDLC (Software Development Lifecycle) and STLC (Software Testing Lifecycle) should be executed in an agile way.

c) Planning plays a key role. Traditional practices such as PERT (Program Evaluation Review Technique) and CPM (Critical Path Method) should be used effectively.

d) Right project management tools should be deployed. Many MES products are also compatible with cloud based automated project status reporting and dashboards.

e) Appropriate stakeholder management and setting the right expectations helps.

f) Template-ization and automation helps achieve the timeline goals, cost and quality in limits.

Template of requirements and functional solutions should be created for managing manufacturing operations for a certain domain, with the ability to create specific customization to the manufacturing line (as shown in Figure 3).

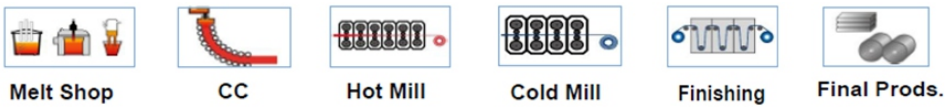

Figure 3: Typical workgroups in above context

Typical functional areas in steel manufacturing are:

- Planning and Scheduling
- Liquid Steel – Coking, furnace, casting
- Production Execution Rolling and Finishing
- Quality and deviation management
- Warehouse and Transport Management

Typical physical areas/group of lines/entities in steel making are:

- Furnace and Casting
- Hot rolling lines
- Cold rolling lines
- Finishing, Coating and Packaging lines
- Templates based on the functional areas should be created for:
- Requirements
- High Level Solution Designs
- Functional Design Specifications

End-to-end traceability should be maintained for the above-mentioned key templates following which the applicability of the functional area templates to the physical group of lines (workgroup) is analyzed. Product-specific, line-specific, low-level designs are made or updated based on this analysis.

#2 Cost

a) MES product selection decision is a trade-off between requirements and budget. Prioritization is key.

b) Template-ization and Automation keep costs in control.

c) Reducing wired networks, and right-sizing servers and databases can help further drive down costs.

d) Release and deployment management stabilization and usage of process improvement tools should be encouraged. Artificial intelligence (AI) and Machine Learning (ML) should be deployed wherever possible to drive faster and more accurate decision-making.

#3 Quality

a) In addition to template-ization and standardization of interfaces, enabling synergies between people, processes and products (3Ps) is key to maintaining quality in large MES transformation programs.

b) Designing and adhering to the right processes across review, version management, risk management, and E2E traceability is equally critical.

c) Well-defined processes must be established for naming the philosophy for deliverables, Master Data, business rules, communication management, test data management and configuration management, along with sound governance.

d) People should be familiarized with new products and processes through a structured competency management process to avoid competency related issues.

e) Template-ization of key messages in MES such as Production Order, Process Data Input, Process Data Output, Goods Movement, Test Interface, and Material Interface is helpful.

Real World Example

Let's consider the example of how Tata Steel Europe managed the timeline, cost and quality related challenges while implementing its MES.

1) In the absence of a template, the work group or line wise MES implementation sequence could have been, as shown in Figure 4 and, very time consuming.

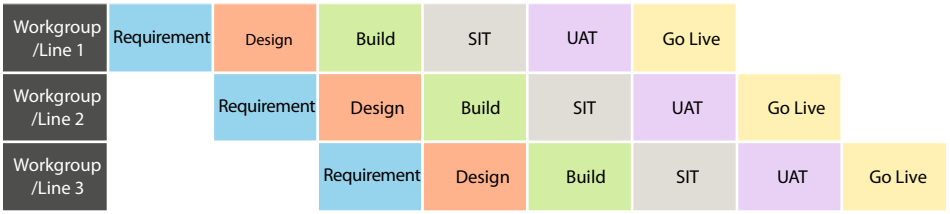

Figure 4: Work group / line wise MES implementation in absence of template

Steps taken: TCS along with TSE opted for Template-ization of requirements and functional solutions.

Moreover, the generic template gets deeper and wider with every implementation, which further reduces time for future implementations. Figure 5 illustrates the current sequence.

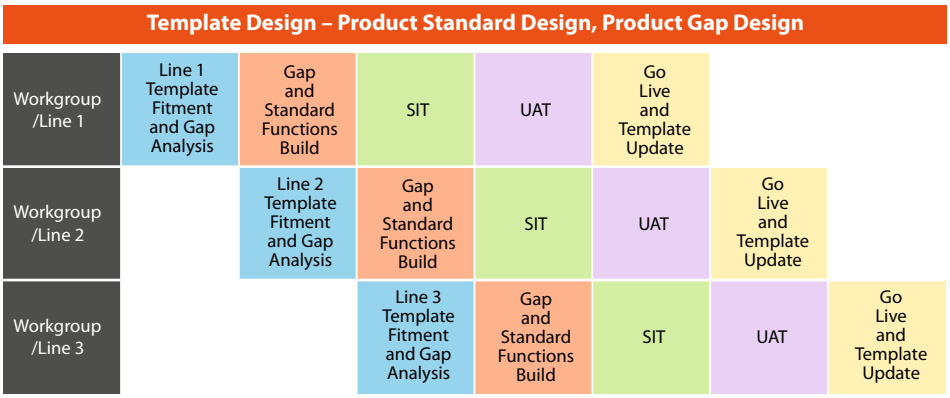

Figure 5: Current sequence of work group/line wise MES implementation

Result: This method has not only resulted in time and cost savings of nearly 40% to over 60% per line in a large MES transformation program but also improved/standardized the quality of deliverables. The line before template solution took nearly 13 months and has been reduced to eight months after the implementation.

1) For Tata Steel Europe time spent in System Integrated Testing is very high due to the multi-dependencies in a large MES program on L2, L3, L4 systems. Additionally, some business scenarios are highly complex and require frequent test data sets. Some scenarios are also highly repetitive.

   To address this, TCS analyzed the applications and systems involved and took special efforts on Test Data Management and deployed automation in testing. HP UFT tool was used for test automation. Reusable automation framework with library has significantly helped save time.

   Result:

   - Achieved 100% automation for Regression Testing Suite (for OCL, DSP, SM)
   - End-to-end testing with 70% reduction in execution time
   - Parameterized test data for efficient use and reusability
   - Monthly production releases with testing of regression suite maintaining 100% test effectiveness
   - 70% time reduction per SIT and subsequently lower costs

2) For Tata Steel Europe, MES has very diverse interfaces with L2, L3, L4 systems and applications. Interface design and building was time consuming.

   Steps taken: Interfaces were standardized. Additionally, the source side, destination side and middleware side attributes for generic-type interfaces were finalized. For example, we finalized templates for PDI, PDO, PO, GM, LAB and other interfaces. Standardization of the interfaces was done even at the level of processing requirements (e.g. Engineering Unit Change/Scaling/Dynamic attribute generation) at middleware.

   Result: Quality has improved drastically and at least 80% reworks on interfaces have been reduced. Post go-live issues for the line implemented after template solution dropped nearly 90% compared with a line that was made live without a template solution.

Moving to a collaborative and connected MES future

With digitalization pervading every aspect of manufacturing, the value of MES has extended far beyond execution. It is now the route to scaling efficiencies and delivering an exceptional customer experience, without escalating costs. The global MES market is expected to reach USD 19.36 billion by 2023 with 34% manufacturers already using MES or planning to implement it in the next three years.[3]

The new paradigm of Manufacturing Execution Systems would be a blend of MES and IoT platforms, where both integrate to form a flexible and scalable platform that can support Industry 4.0 strategies of the future.

Partnering with an experienced MES solution provider with right implementation, execution, and technological expertise can help metal and steel manufactures drive successful MES transformation programs in the Business 4.0 era. Wise utilization of advanced digital technology and tools should always go hand in hand with fundamental practices.

Reference

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About the Author

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Vidula Joshi is currently managing the 'Rolling and Finishing' area in a large MES transformation program for Tata Steel Europe. She has over 17 years of experience in process control, MES and business intelligence. Vidula has worked in development, solution architecture and functional areas on multiple projects. She has developed and delivered trainings in the areas like instrumentation, industrial automation and MES for prestigious Indian and global organizations. Vidula holds the distinction of being the first female instructor to conduct training for TUV (on Advanced SCADA) in the Middle East. She has also spoken at various prestigious international conferences and has published several papers. Vidula holds a Bachelor's Degree in Power Electronics Engineering from BDCOE, Sewagram, Maharashtra, India.

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