

BROWNFIELD MES MIGRATION PROJECTS.

STRATEGIES. CHALLENGES. SOLUTIONS.

Whitepaper

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Introduction

Integrated solutions or systems have an end of life and legacy systems have to be replaced with the new technology or versions to update the business processes and also to update the technological aspects. The cost of maintaining legacy systems on unsupported platforms is high due to limited knowledge. If the system is built in a customized way and maintained by many teams, over a period of time, it has inbuilt hidden knowledge that many will not be aware of. This is cause of concern for customers as it may affect business continuity and is hence very high risk situation.

A "brownfield" project is a term used to represent replacement of existing products and/or services wherein "old is replaced by the New". This is complex when it comes to an execution system that is real-time and that controls critical operations. It is more complex if the old application is built in a customized way and has been in use for many years. There are myriad challenges posed by brownfield replacement projects that too varying in nature. Teams face challenges not only related to technical architecture / solution but also relating to People, Processes & systems, Practices and Management.

Although some of the challenges are common to all brownfield implementations, this whitepaper focuses specifically on MES Brownfield Projects in automotive industry laying stress on key considerations for solution design, requirement & design documentation, process setup & execution, application testing, and project management.

Replacement of legacy MES system with a new one is a costly and risky endeavour which automobile manufacturers have to take up to stay competitive in the current market. But the challenge is that there is no infallible way of doing the migration.

In this whitepaper we have come up with a migration strategy which would minimize risk for the customer but at the same time result into successful completion of the project. We have highlighted key considerations that should be kept in mind for solution design, requirement & design documentation, process setup & execution, application testing and project management applicable to complex & large scale MES migration projects.

We have also discussed various challenges faced by the delivery team in MES migration projects and suggested solutions for each of those challenges.

MES: Acronym for Manufacturing Execution System is an electronic interface between personnel, equipment automation, orders, logistics, equipment and processing instructions. It helps in providing control over each part of production process.

MES helps bridge the gap between regulatory control and operational control. Regulatory affairs are focused on compliance and manufacturing operations are focused on manufacturing and quality issues. By bringing these groups together, MES helps automotive companies reduce time-to-market; improve manufacturing efficiency and product quality, while at the same time lowering manufacturing costs and developing products that meet regulations.

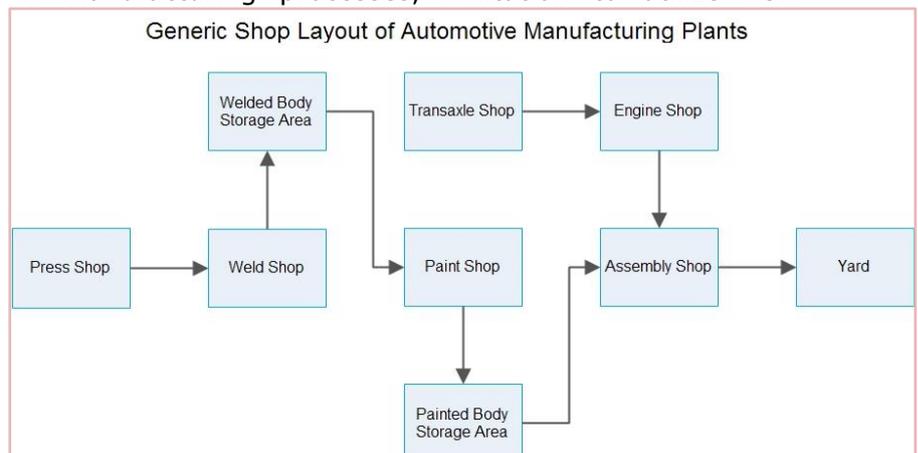
Introduction to MES Replacement

Most legacy MES systems are a combination of hardware and software. Many of them are complex and difficult to understand if they had been developed through customization of a SCADA (Supervisory Control and Data Acquisition) software product with client side code. Even if standard MES products have been used, it again becomes complex and difficult to understand if they have not been enhanced through standard modeling and development approach with good documentation.

Although it is a challenge to replace legacy MES system but with the need posed by the automotive industry and with each manufacturer aiming to improve their time to market, reduce product development cycle and increase manufacturing agility, it is imperative that they quickly need to replace their legacy MES system with a more modern and advanced MES solution.

There are multiple reasons to consider an MES migration to a new system: For example termination of support for legacy system from supplier side, limitation of legacy system which results into loss of business opportunities because it becomes difficult to align IT with the changes occurring in manufacturing processes, limitation to utilize new generation technologies cost effectively.

Many manufacturers believe that their homegrown MES system is irreplaceable because they feel that their processes are very specialized and only in-



house custom built solutions can meet the criterion. Such manufacturers realize the problem when they need a solution which is scalable and can also be extended to other plants. Homegrown MES systems limit manufacturer's capability to scale, improve & improvise. Out of the box MES products (with few client specific customizations) are more suitable to futuristic manufacturing plants.

It is understood that Legacy MES System needs to be replaced but the big question is: HOW? The business team also specifies that due to the migration, manufacturing operations should not be affected, critical data & functionality should not be lost.

Essentially there are 3 strategies for MES replacement project:

Big Bang Strategy

- Least time taking & most cost effective strategy.
- Much preparation is required before Go-Live.
- Most risky & turbulent strategy.
- Testing can not be done on production environment.
- Lab testing / functional testing should be extensive & detailed.
- Once Go-Live is done there is no option to rollback.
- **Suggested strategy for small plants or small isolated modules.**

Phased Strategy

- Moderately time taking & moderately cost effective strategy.
- Preparation required before Go-Live is least compared to other strategies.
- Moderately risky but during migration there needs to be 2 reporting DBs.
- Limited testing can be performed on production but still some emphasis needs to be paid on lab testing / functional testing.
- Limited option for rollback is available.
- **Suggested strategy for small & medium inter-related modules.**

Parallel Strategy

- Most time taking & least cost effective strategy.
- Preparation required before Go-Live is maximum.
- Least risky strategy amongst all.
- Extensive testing can be carried out on production environment before Go-Live.
- Lab testing / functional testing required is very minimum.
- Rollback is easier.
- **Suggested strategy for large modules / plants with high production volume.**

For even larger projects delivery teams can come up with other approaches by using a combination of 2 approaches together or using separate approaches for each shops / modules depending upon complexity and requirement.

In this whitepaper we focus on **Parallel - Phased Strategy** wherein the new MES is setup in parallel to legacy system and exchanges data with the legacy system. Later the legacy system is replaced in a phased manner while it is provided data by New MES system. Parallel - Phased Strategy is recommended for plants where any system downtime leads to huge losses and hence risk appetite is extremely low. This approach requires much detailing, but it lowers the risk considerably.

MESTECH services Pvt. Ltd. is one of the leading MES solution providers catering to automotive industry and life sciences industry. MESTECH adopted Parallel – Phased Strategy to replace legacy SCADA based custom MES in a major passenger car manufacturing facility which has a total capacity of 1000 cars per day. The project was a great success and received appreciation across the domain and the team ensured that there was very minimal production downtime during or post migration.

Challenges Faced

"Being challenged in life is inevitable, being defeated is optional." – Roger Crawford

During the course of the MES replacement project using the Parallel – Phased strategy a number of challenges and risks have to be managed. During the course of defining and planning two major MES replacement projects, MESTECH team came up with some very innovative approaches to overcome the hurdles and achieve the objectives. The challenges are broadly divided into 4 categories and are discussed in detail in this paper.

1. People related challenges
2. Technical challenges
3. Challenges related to Processes & Systems
4. Management related challenges

In contrast to Greenfield projects employees of the customer organization are usually in a comfort zone with their existing legacy MES system even if it has problems.

People Related Challenges

Resistance to Change

It's human nature to resist change. People like to live in the comfort of their habits. In such retrofit projects, employees of the customer organization are usually in a comfort zone with their existing legacy MES system even if it has problems. This is because humans have tremendous power to adjust. This situation is much like the "boiling frog" syndrome.

While initiating a MES migration project it is extremely important to discuss about making people comfortable with the change. Management should take lead and communicate effectively within their organization so that their employees also start looking forward to the new MES project and thus support it.

Objectives of the project not understood by employees of customer organization

In MES replacement projects, very high level of involvement of the employees of the customer organization is required. The delivery team needs their involvement to validate and measure the success. Hence, it is of utmost importance that these

In MES replacement projects the employees of the customer organization are also active members of the delivery team. They are involved in solution validation & important decision making proceedings. So it is of utmost importance that these employees also understand the objectives of the project.

employees also understand the objectives of the project.

Project is not owned across the board

In the initial phase of MES replacement project you will notice that almost everyone in the customer organization especially ones who had put in place the old MES system always support the old system. That's because people support what they create.

For a MES replacement project to succeed it must be ensured that all the stakeholders own the project. It's imperative that ownership is driven from top to down in an organization but here the project manager has a key role to play in MES replacement projects. He has to ensure that requisite stakeholders are involved in decision making and others are duly informed. All the members in delivery team plus the employees from customer org (who are the drivers of change) are aligned together and take project related decisions jointly.

Once they start contributing to the replacement project, ownership will seep into them.

People support what they create.

Almost everyone in the customer org especially ones who had put in place the old MES system always support the old system. They also should own the replacement project for it to succeed.

Strengths of the new product / software are not understood

Let's assume that you owned a helicopter (compare with legacy MES) and now you have purchased a new private Jet (compare with New MES) for air travel. These 2 different products serve same primary purpose of air travel but is it fair to expect that a helicopter's rotor will also be fitted on top of the Jet plane? No. That's because both are different products each having different strengths & weaknesses. It is not impossible to install rotor but it will cost you millions more with no additional value add.

While replacing legacy MES system customers usually expect that everything will remain as it was in the old system and on top of that they will receive something extra. This is where they fail to understand the strengths of the new MES product and hence fail to explore & utilize the new product to its full potential. For the good of the project, it's really important that customers understand strengths of the new product. Otherwise even if delivery team exhibits exceptional performance during the project, customers will remain unhappy in the end.

Technical Challenges

Making system live without disrupting the existing system

During most such replacement or retrofit projects, the delivery team takes an approach of asking for production shutdown which leads to financial losses for the customer. Hence, to minimize the financial loss, MESTECH took an innovative approach and committed to the stake holders to replace the system with minimal system downtime. To meet this expectation a data bridge between legacy MES & New MES system was developed and is key to success of such projects.

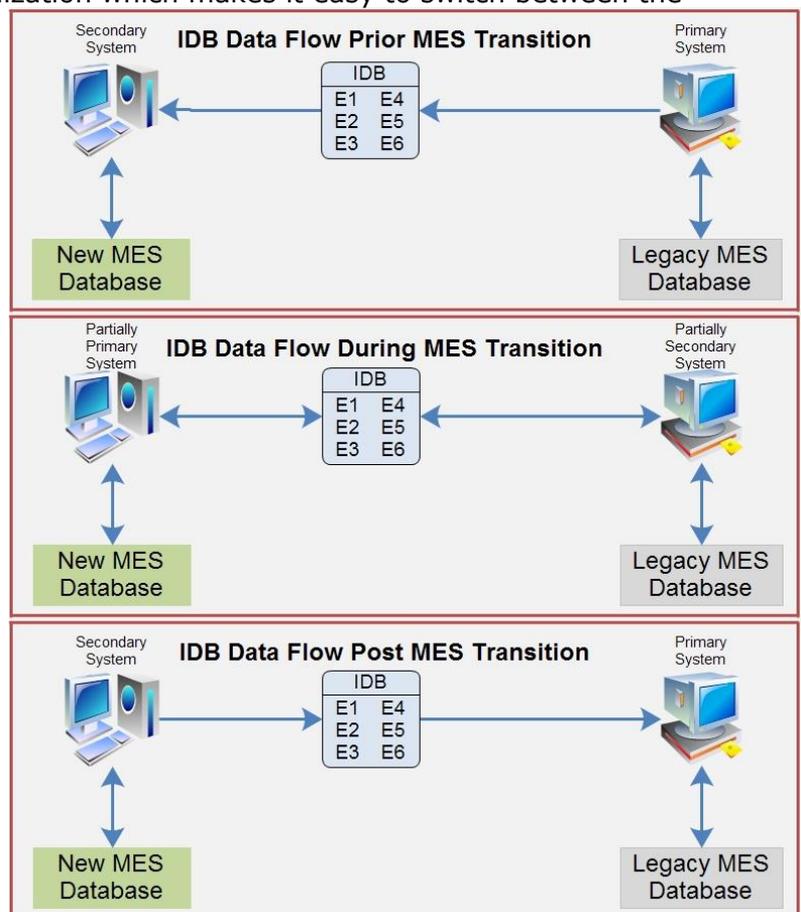
Data Bridge

Data Bridge is a technique used to send and receive data from one system to another. Data Bridge is a mechanism which keeps new MES system in sync with the legacy system. During and post transition period same bridge is used in reverse direction to keep legacy system in sync with the new MES. So practically at any given time both the systems run in parallel and in synchronization which makes it easy to switch between the

systems in case there is any major issue with the new MES system. The system which sends data to IDB is the Primary system (or Live System) and system which picks up data from IDB is the Secondary system (or Parallel system).

IDB: To achieve data transfer between the two systems, the concept of IDB (Intermediate database) is used because while replacing any existing system with a new one, the database structures can be different. Even if DB structures are similar it is wise to use IDB because of its many other advantages. IDB is where events with different operational identifiers can

be stored. The respective systems can then access these events from IDB and process them according to their own database structure.



Data stored in IDB can be classified into two categories viz. Raw Data & Final Data.

- *Raw Data*

Raw data essentially is data which is taken directly from the shop floor i.e. it has not been processed by MES system. For example: Operator scans an item ID number on a particular station on shop floor, this scanned value is Raw Data.

Raw data is placed in IDB to test critical functionalities given that there are no extra validations added in the new MES system for same functionality and thus may not give same results as legacy system.

- *Final Data*

Final data is the data that has been processed by a MES application of Primary system and is ready to be committed to Primary MES Database. Once data is committed into Primary DB it is sent to IDB from where secondary MES system picks it up and usually commits into its own DB without running any further validations on it.

Final data is used in case of non-critical functionalities, functionalities with extended validations in new MES and in cases where there is dependency on shop floor devices.

During MES transition there can be a need to switch between the two systems to avoid any production down-time. This can be achieved by changing the sending and receiving events of the primary and secondary systems. The switch should be done after ensuring that there are no receiving events pending to be processed.

So using Data Bridge, complete new MES system runs parallel to entire legacy MES system. This is the stage where project has attained Parallelism. Now, once you validate that the new MES system is giving results similar to legacy system then you can start MES migration. The migration is done in a phased manner preferably station by station. But, you can choose to replace multiple stations or a shop altogether depending upon the complexity and criticality of the applications. Once a station is replaced by new MES, immediately the Data Bridge for that station is reversed and new MES starts sending data processed by that station into the IDB from where legacy MES picks it up and updates its own DB. In case there is any major issue then legacy system for that particular station is made active. Hence, downtime can be avoided while migration.

Dry Run

During plant shutdown a dry run can be performed to check for and avoid any possible system failure prior to going live. Functioning of complete bridge can also be verified through dry run. To perform dry run, dummy orders are processed end-to-end in a shop. This validates proper shop functionality and working of bridge between the two systems. During dry-run switching between systems can also be tested to ensure that both systems are able to process orders as intended.

WIP data migration

Considering the fact that downtime has to be avoided while replacing legacy MES with new MES when the production is still running on the shop floor, it is important to bring WIP in the new system in sync with the legacy system. The amount of WIP data can vary from plant to plant depending upon their processes and plant's size. Data Bridge itself can be used to build WIP data in new MES else WIP can also be updated manually which would require additional efforts by project team members.

Historical Data Migration

Historical data is data for which processing on all stations has been completed and is now available in DB only for reporting purpose. It is highly recommended to keep historical data separate from new MES data because legacy system will have data of several years and merging old MES & new MES data will overload the new MES from day one. Besides, it will be too complex if DB structures are different (which is very likely). For old reports purpose historical data can be kept available in new MES but in a separate DB instance.

For historical data migration important factor is the cut-off date which should be decided and agreed upon with all the stakeholders before migration. The cut-off date is dependent on how long an order remains open and the frequency of an order being open for long. In general 1 month's data (based on Go-Live date) can be kept as WIP and all past data can be considered as historical.

Challenges Related to Processes & Systems

In MES replacement projects operational processes & third party systems & devices are already in place and are difficult to change. Whilst in Greenfield projects you have the opportunity to align all processes and systems. So in MES replacement projects delivery team has to find ways to interface with existing systems and handle existing processes.

Integration with existing systems & devices is complex

This is humongous task because more often than not interfacing with old systems & devices can become a tedious job. In most cases the original supplier of the existing systems & devices would have terminated support. So if you are having trouble in interfacing, you are on your own. Getting in right people who can assist you in understanding and interfacing with existing systems & devices is a challenge in itself.

This point should be discussed diligently with client's management and they should make sure that right set of people are available for providing appropriate help during the integration.

The delivery team should identify systems which are to be integrated and perform a POC with all systems & devices in the initial phase of the project. That's because the project timelines shouldn't suffer whilst management ropes in expert help in case of issues during the integration.

Change in operational processes is improbable

In Brownfield project the possibility of modifying an existing process is minimal. Years of operational practices become the culture. So even if you are bringing in improvements with new MES it will not be welcomed. Production managers will not be willing to change shop-floor practices for a new MES solution.

The employees from the customer org who become driving force behind new MES system should be brought in to highlight the benefits of new MES and changes in processes to the production managers. If the production managers could relate the change in processes to their benefit then they would certainly support the changes suggested.

Management Related Challenges

Requirements are documented, Expectations are not

Well, as part of any MES replacement project requirements usually are documented by delivery team but not every delivery team takes pain and overcomes the challenge of documenting the expectations of top management. In Greenfield projects top management's expectation is only to build MES solution with high availability ensuring that production & quality managers are happy. But in case of MES replacement project the expectations are much higher and diverse. If these expectations are not understood

and documented then the replacement project will eventually make the top management unhappy. So it's better if you document the expectations as well and share it across the board so that everyone is aligned.

Quarterly Meeting between Top management and development team

Implementation of large scale MES replacement projects usually takes couple of years to complete. In such long duration projects it is not unlikely for development team members to lose focus and interest. Regular quarterly interactions with top management can motivate the team members because they feel noticed.

For the project manager it is a difficult task get all top management personnel into a discussion room with the development team because no one has the time. But management needs to understand that there might be some ground level issues which never get highlighted through the formal channel. For example what if there are issues in the formal channel itself? What if the team is not happy with the Project manager? How would the top management come to know about such issues?

Top management should take feedback from development team and get to know their concerns about work culture, development process issues, people issues etc. Such interactions bring forth hidden issues which may impact the project in the long run.

Key Considerations

Requirements capturing & documentation

Diligent documentation of requirements is a must for any project. But for MES replacement project following points should also be kept in mind.

a. Old System will continue to update gradually

While the delivery team is undergoing development processes the sustenance team of the old system will continue to make modifications in the old MES systems to address productions issues and eventually they will also become requirements for the replacement project. So the requirement capturing team needs to understand this situation and need to bear this in mind while documenting the requirements.

Customers also should understand that making changes in legacy system during the development process of new MES system should be kept to a minimum otherwise it would undermine project success rate.

b. For As-Is replacement, capture what is As-Is

For MES replacement projects while providing the requirements customers often mention that they need an As-Is replacement. Requirement team shouldn't simply mention this statement as a requirement. Instead they should get details about the As-Is system and mention them as the requirement after verification from the customers. Also do not forget to clearly capture performance levels expected.

Design detailing & documentation

The most important point to consider while designing the solution of new MES is that the design should be done so as to cover current as well as future requirements of the customer (refer point a & b above).

The design of the solution should also be discussed with the sustenance team of the legacy system as they might provide you with valuable inputs on loopholes of the legacy system and also provide additional functional inputs. But yes, if there are any functional changes that you notice at this stage then they should go through official change management process.

Opportunities

A MES replacement project offers multiple opportunities besides only upgrading the system. Following are the additional benefits other than reduction in downtime, lower manpower requirement, lower errors that can be derived through MES replacement projects.

- Remove unwanted / waste data.
- Correct / Improve shop-floor processes.
- Standardize the system.
- Optimize networks & datacenters.
- Build a scalable MES system.

Recommendations for New Systems

We have understood that Brownfield MES replacement projects are complex and challenging but then the million dollar question is: Is there a way to manage an MES system so that after 10 – 15 years its replacement isn't a head scratching challenge?

The answer is, "Yes". MES replacement can be a relative smooth ride if the first system is managed and a standard enhancement approach is maintained. There are few important points to keep in mind while sustenance of MES systems:

- Project Documentation should be updated if any change is made in the system.
- Changes should be made considering complete solution and not only the module which needs modification.
- New people joining the support team must be trained on the solution, the design approach.
- Design and code reviews must be done by agency that designed the new system and must make sure standard approach is taken.
- Change management system should be set up and followed religiously after Go-Live.
- In-depth knowledge transition should be done when a resource leaves the project.

About MESTECH Services Private Limited

MESTECH Services Private Limited is a Manufacturing IT consulting firm headquartered in Pune, India with operations spread across India and US.

We focus on Technology Consulting and Software Implementation for managing Manufacturing Operations. Our solutions and services are related to manufacturing execution in several industries, with specialization in the life sciences and automotive verticals. Our aim is to help organizations automate their operations management processes. We have been successfully delivering technology consulting services across the globe (India, China, Japan, Europe and the USA) to Automotive and Life Sciences majors with focus around implementing Manufacturing Execution Systems. We execute projects from concept to completion, wherein we start off with requirements gathering and end with commissioning the system onsite, followed by support and enhancement. We also provide staffing to our clients where our consultants play a key role in implementations that are managed by them. Furthermore, we specialize in Rockwell Automation's MES solutions (FTPC, FTPS) that are based on their FactoryTalk platform. We are strategic MES partner of Rockwell Automation (RA) and have grown to about 75 people over the last 3 years and expanding our reach globally through increase in productivity, and specialization in MES.

The whitepaper has been written with experience from three major MES replacement projects which MESTECH participated in. One of the projects was in a major automotive assembly facility in Pune, India, the other was a system transition in a major electronics manufacturing facility and the 3rd was the MES replacement requirements study and design specification for a truck manufacturer in Japan.

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