WHITE PAPER

AGING CONTROL SYSTEMS – A THREAT TO LARGE ENTERPRISES?

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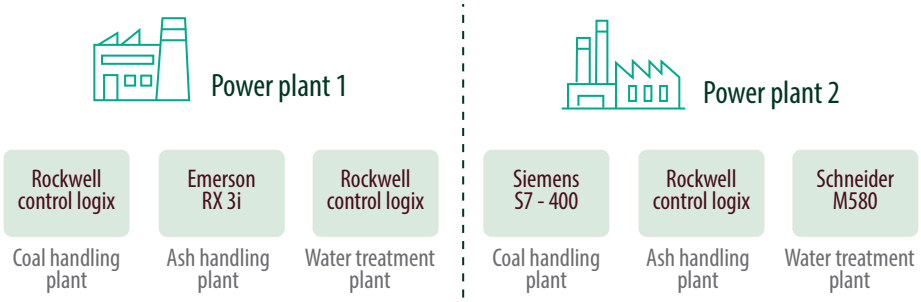
Introduction:

With the progressively rising momentum and adoption of Industry 4.0 and Industrial IoT solutions, large enterprises especially in Manufacturing, Retail/CPG, Mining and Metals, Oil & Gas and Utilities sectors with large asset footprints have been focussing very strongly on means to optimize and modernize plant operations and thereby improve productivity, reduce costs and increase cybersecurity resilience of their plant automation estate. There are a wide range of solutions from Integrated Remote Monitoring to Prescriptive Maintenance that plant operations teams have been evaluating and deploying as part of this digital journey. These enterprises have been creating dedicated digital organizations to focus and deliver use cases that would enable them to accelerate their growth and stay ahead of competition.

In this paper, we will discuss the impending risks of not modernizing the Industrial Automation landscape and what large enterprises need to do to accelerate the replacement of their existing end-of-life Industrial Automation assets.

The late part 1900s and early 2000s saw many industrial plants being set up as part of a very fast growth curve using the knowledge on Industrial Automation from American, German, Japanese, British, and Dutch enterprises which led the first wave post the second World War. These plants were powered and managed by automated control systems – Distributed Control Systems and Programmable Industrial Controllers. These systems evolved from the genesis of Industry 3.0, have since been sitting in large cabinets in the corner of all sizes of industrial plants keeping the operations running 24 x7x365 days for the past decades. These have ensured error free automated plant operations for many years, making them one of the most reliable, yet neglected pieces in the capital allocation strategies of large enterprises looking towards software for the next wave of transformation programmes.
We think the time has come for the industrial companies concentrating on new digital strategies to relook and secure their industrial foundations.
We also think ageing control systems are a ticking time bomb due to their age in operations, which could catch these enterprises unawares and cause significant unplanned downtimes affecting production, reputation, and loss of competitive edge. We further believe, both the suppliers and the users of such ageing control systems do not have the necessary skills and scale to plan for and execute a large scale modernization that may be required to mitigate the risks of this legacy that exist in the industrial plants.

Fig 1 Example of control systems in two different power plants



Scale of the Problem in Hand:

In the typical plant operations at a site, depending on whether we are looking at a Mining, Power generation, Retail, Logistics, Pharma or Manufacturing plant, we are looking at anywhere between 20 to 50 Control Systems installed and in operation. Though companies in the modern era have started ensuring that they get systems from a single OEM, the older installations would on an average have anywhere between 3 to 4 OEM makes and may also have multiple models of control systems from same OEM installed in their plants as part of different process/equipment packages. Figure 1 is an example of some key control systems in two different power plants of a single enterprise.

Over the years, these enterprises have also grown inorganically by acquiring multiple assets from different other enterprises/competition. With all this legacy of self-owned and acquired plant assets, the installed diversity of control systems is complex and large.

The control systems in general are very reliable and have a very high MTBF, hence making them one of the most reliable at the same time ignored areas in the plant operations from maintenance point of view. The control systems typically Bathtub curve lifecycle and hence there are very low rates of failure once these are installed and working. This reliability eventually leads to a lack of capital allocation strategy for planned replacement of these systems in time before the failures start to happen.

The local maintenance teams utilize their maintenance budget to buy spares and keep piling up inventory as a fallback plan to mitigate risks. The local control system integrators are also happy to propose stocking of spares that yield higher margins, rather than discussing the risks of aging systems installed in a particular plant and where they are with respect to the life defined by the OEM in their product life cycle. The OEMs have also not been able to track their installed base effectively to guide their customers well.

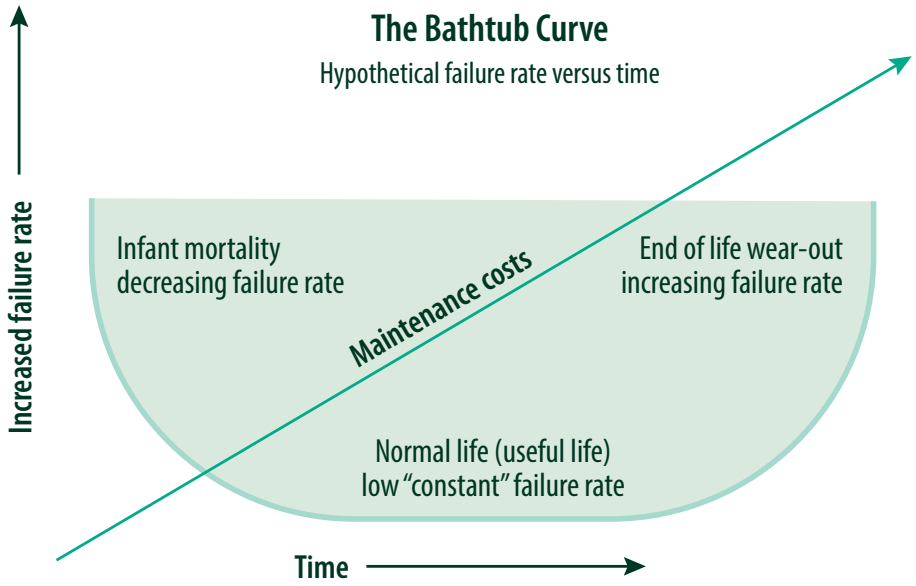
This has resulted in lot of these large enterprises carrying more than hundreds of systems past their "End of Life". Many of these enterprises unfortunately are not aware of the systems installed due to lack of reliable asset management / inventorisation, and hence also not clued into the looming risks that these ageing assets puts them in.

Why is this such a significant risk:

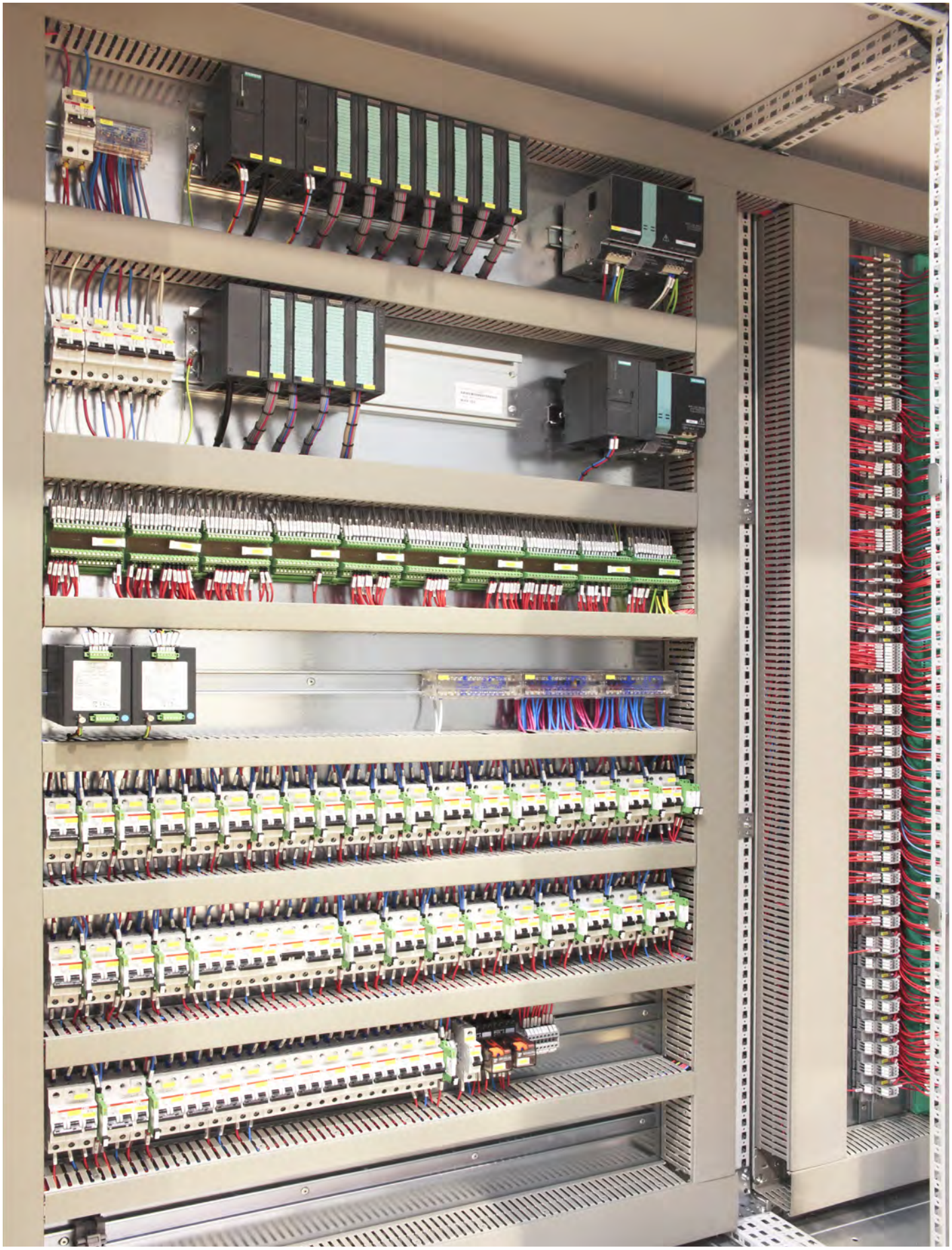
Every industrial component has a lifetime of operation. When any part of the control systems fails after breaching its end of life, the maintenance team struggle to have clear answers to the following questions –

1. Are the required spares available? – The maintenance teams have piled up spares, but do they have the right ones? Do they possess a controller or communication card as a spare? Spares are usually purchased in terms of the percentage of installation. As a result, controller and communication cards are few in number and expensive, and there may be no spares when required.
2. If the answer to the first question is "yes," then the next question is if there is software available to reconfigure and bring back the system live? However, these 10 – 15 year old systems would have been configured with programming software from the same period. Even if the software is available, it would need the relevant operating system to run, which is a big hurdle to cross.
3. Once you clear the first two hurdles the third one is to find an engineer who is still aware of the old programming and configuration software to revive your system. If you don't have an engineer internally, you need to reach out to your integrator/OEM. For them also to find a senior resource who has the experience is going to a be a challenge considering how iterating the workforce is today
4. The next challenge is dealing with the downtime when the system is being repaired. Will the business be ready to accept the downtime for carrying out the repairs and time it would take?
5. Finally the big question is if you have failed at the first hurdle, how much time does it take to source a maintenance spare for a the product has been discontinued by the OEM? Does the OEM even exist? Has he sold his business to anyone else? Whats the commitment that new company has towards the old product?

Fig 2 Bath rub failure cure



Failure rates and maintenance costs have been shown to increase as equipment reaches the end of its useful life.



Maintenance and operations teams must contend with these five challenges when plant operations are down. In addition, they must determine downtime, generation/ production loss and outage and loss to brand image. Worse, once a system fails, other cards in a similar lifecycle phase also starts to fail sequentially, increasing the production loss due to downtime.

Hence, identification of end of life risks in the Control System installations and planning a strategy for modernization is very important for enterprises.

Why is modernization an important milestone before Enterprises can move forward in their digitization journey

Enterprises must modernize their aging infrastructure before investing significantly in other solutions, including digitization. In the previous section, we have seen the risks involved in case of any failures and challenges to fix the same.

The need for this modernization is paramount considering the benefits it offers –

1. Provides a solid foundation for Industry 4.0
2. Eliminates Cyber Security threats
3. Prepares for future virtualization and cloud enablement
4. Eliminates dead spares inventory
5. Reduces human, environmental safety incidents
6. Increases reliability of the entire plant operations

How can they approach on the modernization journey?

Enterprises must act fast to eliminate this ticking time bomb. Some of the recommended steps that enterprises can take up to know the risks and plan to mitigate it -

1. There needs to be a dedicated assessment program to capture control systems inventory and review the risks. The risk rating should be derived based on the systems installed, their lifecycle, spares available, knowledge of programming/configuring the systems. This would be a onetime exercise – complex but much needed to ensure they don't encounter any massive shutdowns. Post this exercise they should be able to automate the inventory management to ensure they are able to track the installation life cycle in more structured and organized way along with necessary alerts and notifications.
2. Based on the risk index they need to come out with a plan to manage their installations. The plan should have three categories for modernization –

   a) High Risk system – Systems declared End of Life by OEM and no spares support and no spares available in your inventory

   b) Medium risk system – Systems declared End of Life by OEM and no spares support but spares available in your inventory

   c) Low Risk system – Systems declared as End of Life by OEM but they continue to sell spares for committed duration of time
3. Once the plan is firmed up, they need to decide on the makes of the control system. Are they planning to modernize the systems with the same make or do they want to have a common platform across their complete landscape for ease of management. This would be another important bearing that would decide the course of control

Fig 3 Risk Classification of the systems

OEM end of life declaration	OEM spares support stopped	Inhouse spares availability	Risk classification
YES	YES	NO	High risk system
YES	YES	YES	Medium risk system
YES	NO	YES/NO	Low risk system
NO	NO	YES/NO	No risk system

system management for the next ten plus years. Many enterprises decide on a single make which has its own risks. In certain cases enterprises choose products based on the regional preferences. We would recommend to keep two makes to ensure you are able to get the competitive benefit and mitigate some of the risks on having a single supplier.

4. If the risk Index is on the higher side and they have a high volume of control systems in the discontinued state than relying on a smaller systems integrator locally implies a long time for the risks to be mitigated. In such a case, it would be beneficial to combine a large global engineering integrator and a local integrator to manage the scale, cost and efficiency better.

5. Create a roadmap of systems to be replaced. This is a complex exercise that needs to consider the system's complexity, impact on production, cost and availability of downtime. Again, a scientific approach needs to be used to arrive at this roadmap to ensure an agile and smooth change over.

Fig 4 Risk Evaluation

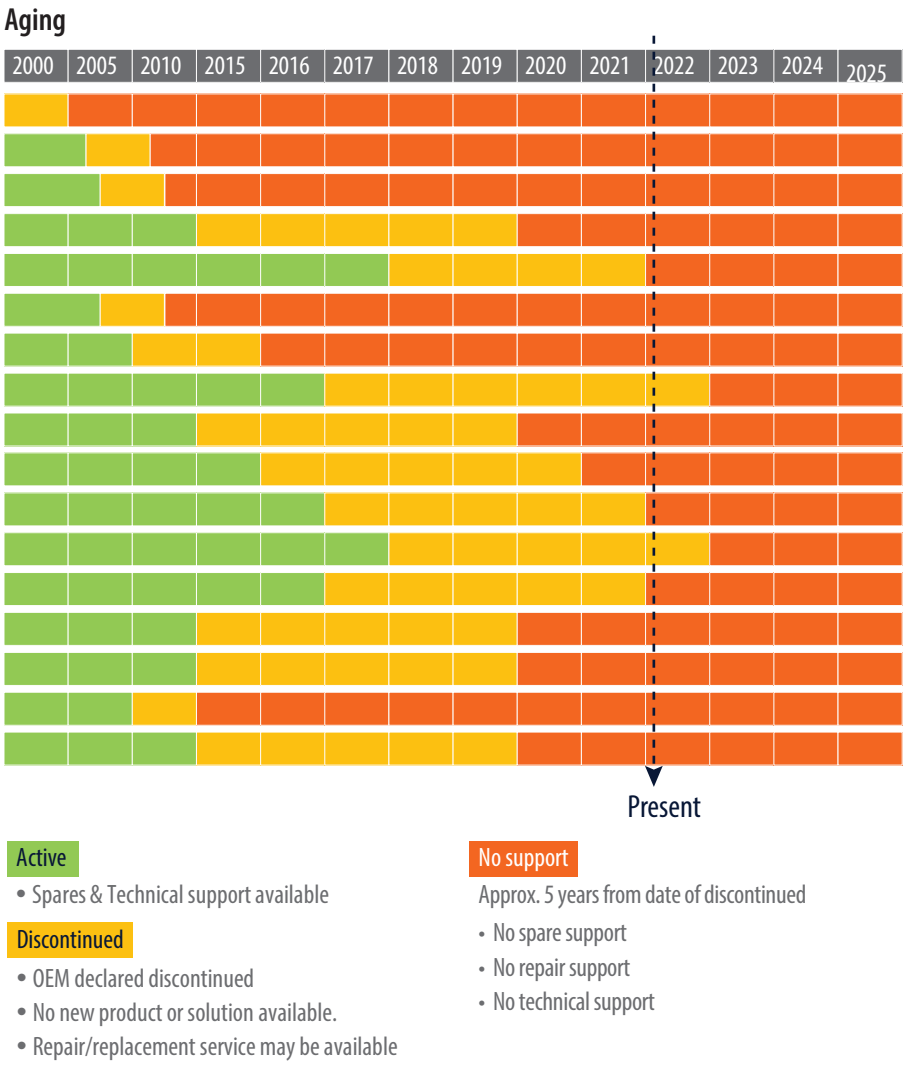
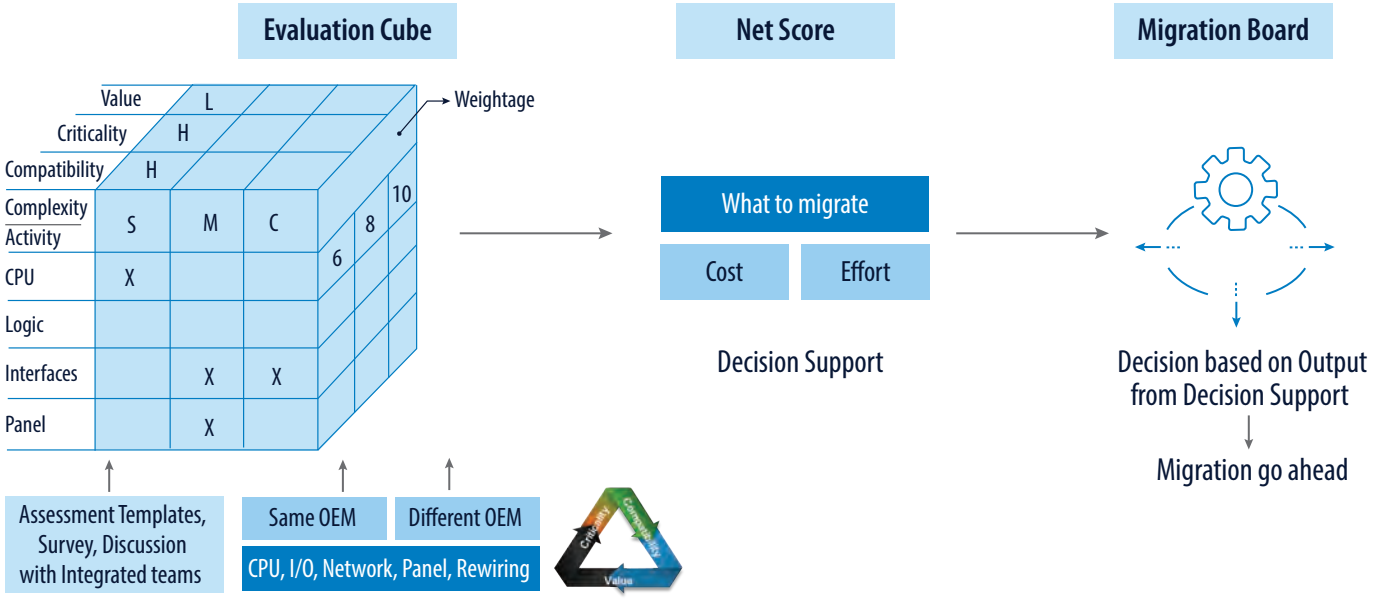


Fig 5 Decision approach on which systems to modernize



How do you execute this?

Depending on the scale and volume of modernization that is required, the most important activity would be to select a partner who can support in the following –

1. Program management
2. Selection of the right products
3. Planning and creating a proper roadmap for modernization
4. Engineering and design
5. Manage scale, cross geographical needs, costs and delivery speed

Once the partner is selected, the next important step would be to select the right product to help the operations teams mitigate risks faster. The partner can also help build the evaluation matrix to simplify the decision-making. Below is one such sample product selection criteria that can be used for selecting the right product.

Once the partner and the product are selected then move into the execution.

The execution must be broken down into key activities.

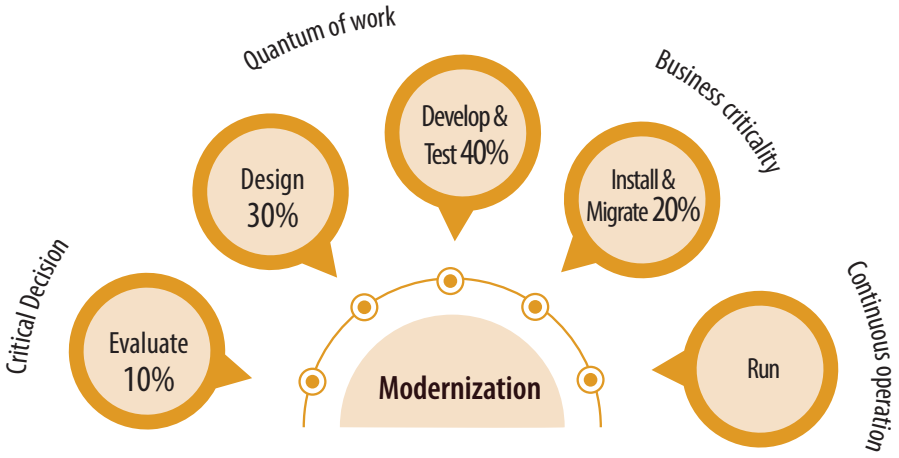
1. The Evaluation Activity- This is done by a combination of on field work and remotely carried out study. The activities would include

- Identify the complexity of the system
- Understand the associated software and hardware affected by modernization
- Schedule migration in non-production time
- Set up fallback strategies that allow rollback to the previous hardware and software platform in case of issues
- Minimize the risk of modernization through detailed planning; identify the dependencies, check if the existing cable, panel, IO subsystem can be retained.

Fig 6 Product Selection Criteria

Criteria / Make	PLC A	PLC B	PLC C	PLC D
Controller specs	●	●	▲	●
I/O handling and expandability	●	●	●	●
Communication protocol	●	●	●	●
Support for redundancy	▲	▲	✕	▲
Communication option (additional)	▲	▲	▲	▲
Operating specifications	●	●	●	●
Dimentions and mounting	●	●	●	●
Programming options	●	●	▲	●
I/O specification	●	●	●	●
Compliance to UL, CE standards	●	●	●	●
Support in Singapore	●	●	●	●
Integrators in Singapore	●	●	●	●
References in industrial application	●	●	●	●
Pricing	●	▲	●	▲

Fig 7 Key activities during modernization and post modernization



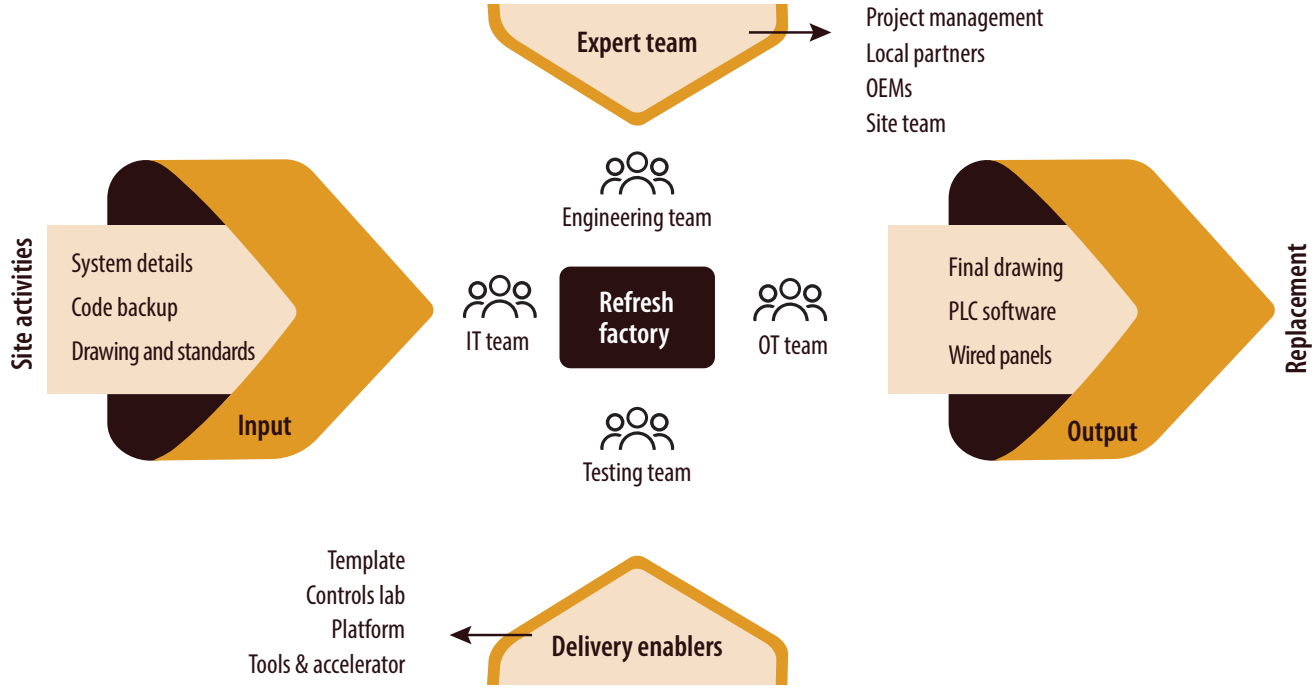
2. The Design and Development Activity

This activity accounts for more than 70% of the work. This is where the partner plays a key role to help managing the scale of repetitive offline work. They can set up a "control systems refresh factory" of multifunctional teams working progressively to

a) Update Engineering drawing for new system

b) Migrate code from previous system to new system

Fig 8 Modernization Factory set up



c) Test using simulators the complete migrated code and HMI functions

d) Create a installation plan on how to move from old system to new system

e) Safety Net- How to fall back on the old system in case of any issues with the new system

f) Retire old system

The Refresh factory can work on activities from multiple sites in parallel, ensuring accelerated modernization ensuring minimal shutdown due to a fully tested and validated design and development.

The core value addition that the partner and the Refresh factory concept brings to the overall modernization is the ability to automate and bring in intelligence into the activities using modern IT tools and techniques –

- Update engineering drawings using Image Analytics, AI and Machine Learning
- Conversion of code from one make of OEM to another OEM using AI and Machine Learning
- Utilize simulators and automated testing to ensure all test scenarios are validated for the complete PLC Code along with interface management with SCADA and other systems
- Installation and Migration guidance using augmented reality and knowledge platform driven digital work guidance

3. Install and Migrate

The program management team would be required to handle proper co-ordination and collaboration management between Refresh Factory teams and the partners. The local integrators familiar with of the site conditions will also play a valuable role in ensuring timely completion of activity.

Completely validated code and intelligent marshalling combined can help reduce the downtime requirement and hence reduce the resulting production losses due to downtime.

Multiple modern marshalling techniques have started helping customers simplify the onsite activities both in terms of the accuracy of modernization as well as time taken for the changeover.

4. Run

Post the installation, keeping the system continuously operational and up to date in terms of firmware updates, service packs etc should be entrusted to the partner who can use develop shared services model to continuous monitor and keep the systems up to date ensuring near 100% availability. This would ensure that the enterprises are able to upkeep their control systems in the best way with minimal cost without significant investment on man power including trainings, licenses and spares.

Hence, we recommend enterprises to judiciously select the right partners who can form the required teams in timely manner and manage the modernization with minimum disruption. This would ensure the risks are handled and taken care of.

Conclusion:

Large enterprises must acknowledge that the control systems need as much care as large machinery. They must become aware of the risks they carry and immediately plan to mitigate them. This would help their plant operations become safer and more reliable. In addition, it will help enterprises remain competitive in the modern era with minimal downtime and maximum productivity. They also need to identify the right global partners to enable them on this journey. Managing a mass modernization initiative would be challenging with the traditional OEM and local integrator partnership approach. There is definitely a need for a larger solution partner to scale and manage these large programs effectively and economically. It is, in fact, a critical factor for the success of the modernization program.

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