ICxA Industrial Commissioning Association

PROJECT COMMISSIONING

START WITH THE END IN MIND

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INDUSTRIAL COMMISSIONING ASSOCIATION
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About the Industrial Commissioning Association

The Industrial Commissioning Association is the only global organization representing individuals and companies involved in commissioning of industrial plant process/energy systems. Our goal is to improve the performance of major capital projects with best-practices for commissioning planning and execution.

Project Commissioning - Start with the End in Mind

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CEO Foreword

There is an unprecedented volume of project work ahead of us, with industrial plant process and energy system projects required for decarbonization and climate change initiatives, electrification of our infrastructure, and to meet the expanding needs of society for resources and waste treatment. However, the data shows that most projects are completed late and overbudget. It is clear we must improve project performance, if we are to to meet the demand for new infrastructure to help address the global challenges that society is facing.

Commissioning plays a large role in project success, yet the commissioning discipline has been under-utilized and misunderstood on projects for decades. Commissioning is a complex discipline, and not well understood by groups working on projects.

Commissioning best-practices, including early involvement during procurement and FEED processes, must be undertaken if projects are to improve performance.
The solutions for improved commissioning exist, but how do we integrate these solutions into daily activities on-site. The challenge is one of adaptation and proliferation.

CEO Foreword

The construction industry needs a new approach to commissioning, and new ways to plan for a strong project finish – the current application of late-stage planning for commissioning is clearly not working and drives all the wrong behaviours. All groups working on projects must align their objectives on the primary goal of projects – which is always successful commissioning and startup to meet the project's cost objectives and planned in-service date, for reliable operation of the new plant facilities for the life of the assets. Starting with the end in mind is the only way to guide project groups to success at the end.

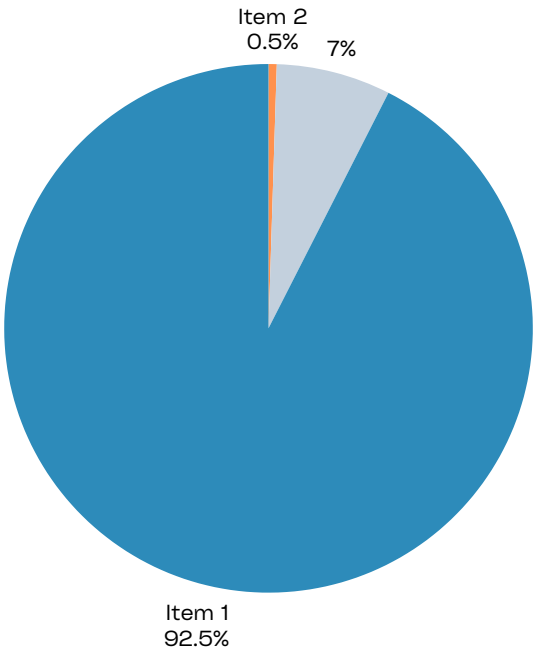
This report outlines the steps needed to elevate the importance of commissioning on projects, and to ensure early engagement of commissioning on projects, so that all stakeholders can achieve maximum value. Early engagement of commissioning is not a "nice-to-have" for project teams to consider – it is a critical priority to improve the under-performance of projects to deliver society's critical infrastructure.

Paul Turner
CEO, Industrial Commissioning Association (ICxA)

ICxA Industrial Commissioning Association

Why Does Commissioning Matter

In today's rapidly evolving industrial landscape, 92.5% of projects (Item 1) fail to meet their cost and schedule objectives, and only 0.5% of projects (Item 2) meet cost, schedule, and the intended outcome of the project (source: Bent Flyvbjerg, How Big Things Get Done). These staggering statistics highlight a critical oversight – commissioning is often an afterthought, rather than a foundational pillar.



All fundamental phases of major capital projects – procurement, design, construction, and commissioning – must all be planned in conjunction with each other to achieve cost, schedule, and quality objectives on projects. When one of these phases fail, the entire project fails.

Yet often there is very little upfront effort and planning for the commissioning phase of projects, arguably the most complex phase of projects.

Commissioning planning must take place at the same time as planning for procurement, design, and construction. Planning for commissioning must start during procurement and FEED processes, so that all phases of projects are aligned with each other.

Imagine cooking a three-course meal: you prepare the appetizer and main course in advance, but while your guests are still sitting at your table, you search for a dessert recipe and start making a chocolate souffle last-minute. The flow of the dinner is disrupted, and your guests are impatient because the dessert wasn't planned along with the other courses.

When there is only upfront planning for design and construction, and planning for commissioning is not undertaken until just prior to on-site testing activities begin, the design and construction phases of projects will be out of alignment with commissioning and startup activities. This translates into missing and/or late deliverables and out of sequence work packages that do not allow for successful commissioning and startup to achieve the project objectives.

There is typically only one sequence of activities that can take place during commissioning and startup (with some small variations). For example, a 230 kV AC switchyard cannot be energized and tested until the incoming 230 kV transmission line is complete construction. This is a large example, and a smaller example may be a header section of pipe feeding a particular plant process subsystem. With no incoming process fluids, there is no opportunity to start up the plant subsystem, without first having the incoming header available to provide process fluids.

Because of these technical dependencies, there is a relatively rigid sequence of tasks to complete in a specific order for commissioning and startup to achieve the project's in-service date.

Understanding the project's commissioning and startup sequence during earlier phases of design and construction is necessary to align all preceding activities, ensuring a strong finish at the end of project to achieve the startup sequence.

When commissioning is an after-thought on projects, one of 2 things happen:

In-Service Dates are Maintained with Unreliable Systems

Project in-service dates are maintained, with unreliable and partially functioning systems being placed into commercial service. This causes unplanned outages and forced shutdowns during normal operations to address issues that were not properly identified during a thorough commissioning process.

In-Service Dates are Delayed

Project in-service dates are delayed, while project teams attempt to make sense of what is complete, what remains to be finished, and the steps required to integrate equipment into one functional plant process

Both of these situations are money-losing scenarios due to downtime of the facilities, missed production targets, and lost opportunity costs to generate value from the new plant facilities.
To avoid this, early commissioning involvement is required to plan and coordinate commissioning, and to mitigate project risk. Projects are complex, and there is an endless list of things that can go wrong.

> **Prepare For a Bad Day**
>
> Keith Parrish,
> Commissioning Manager of the James Webb Space Telescope

Identifying what can go wrong and mitigating these risks early in projects tremendously helps project teams prevent costly delays later when issues are much more expensive to address.

Commissioning Project Managers (CxPMs), who have participated and understand the end of projects, and know what to watch for, help project teams avoid costly pitfalls. This only comes from specialized skillsets and experience from commissioning groups. Until CxPM skillsets are applied earlier in a project's lifecycyle, project teams will continue to struggle to deliver projects on-time and on-budget. Projects require a similar approach to manufacturing, where the person at the end of the production line is pushing all earlier activities to maintain output from the process.

A structured and organized approach to commissioning project management, defined upfront in contracts, gives all project groups a clear understanding of the goalposts they must achieve, with a much more efficient completion of projects. However, when the commissioning goalposts to finish projects are left undefined, each project group must make their own assumptions on what success looks like during commissioning, with everyone having a different understanding since commissioning is not a well understood discipline.

Commissioning matters on projects because it is the methodical process to efficiently finish projects. And finishing projects is the most important part – finishing projects is the primary reason they are started in the first place.

Commissioning is the critical execution phase of projects to confirm project owners are getting the value they paid for.

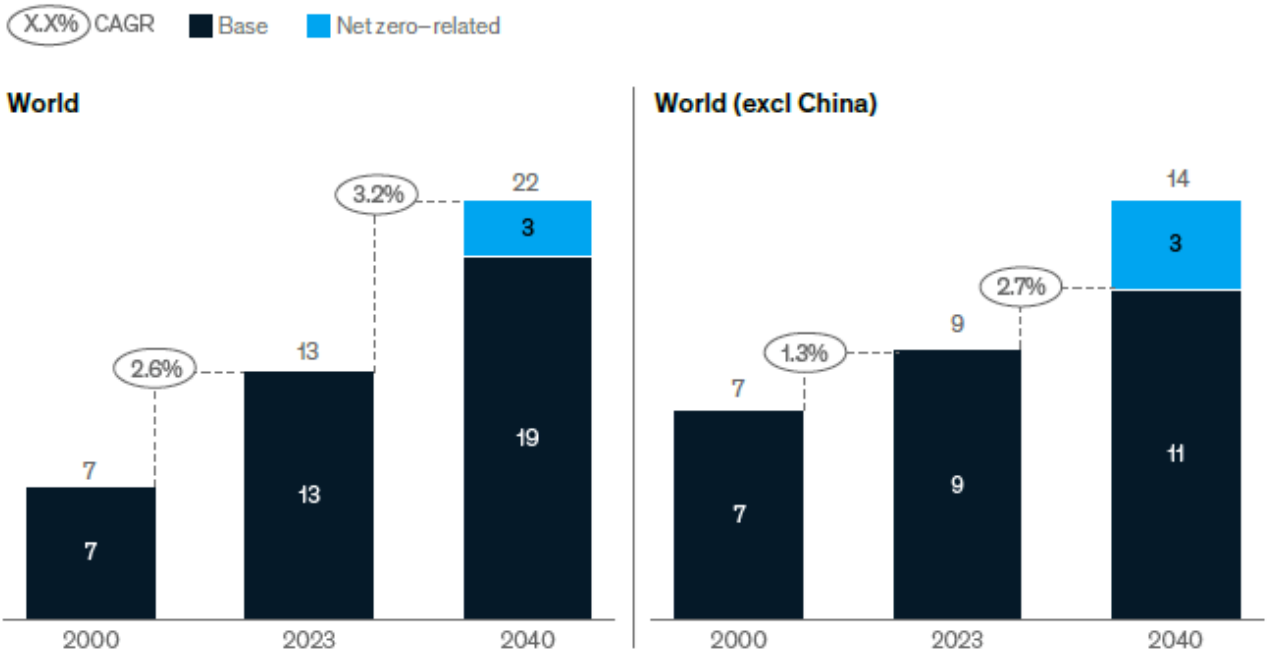
Let's now explore the systemic problems hindering effective implementation of commissioning best-practices on projects.

The Challenge With Project Commissioning

McKinsey & Company's report released August 2024 titled: "Delivering on Construction Productivity is No Longer Optional" indicates the following:

> "The construction industry is the world's largest industry at $13 Trillion annual spending, and is projected to escalate to $22 Trillion by 2040. It is projected that the construction industry needs to double to meet demand by 2040."

Annual construction spend, $ trillion (real 2019),[1] 2000–23 and 2023–40



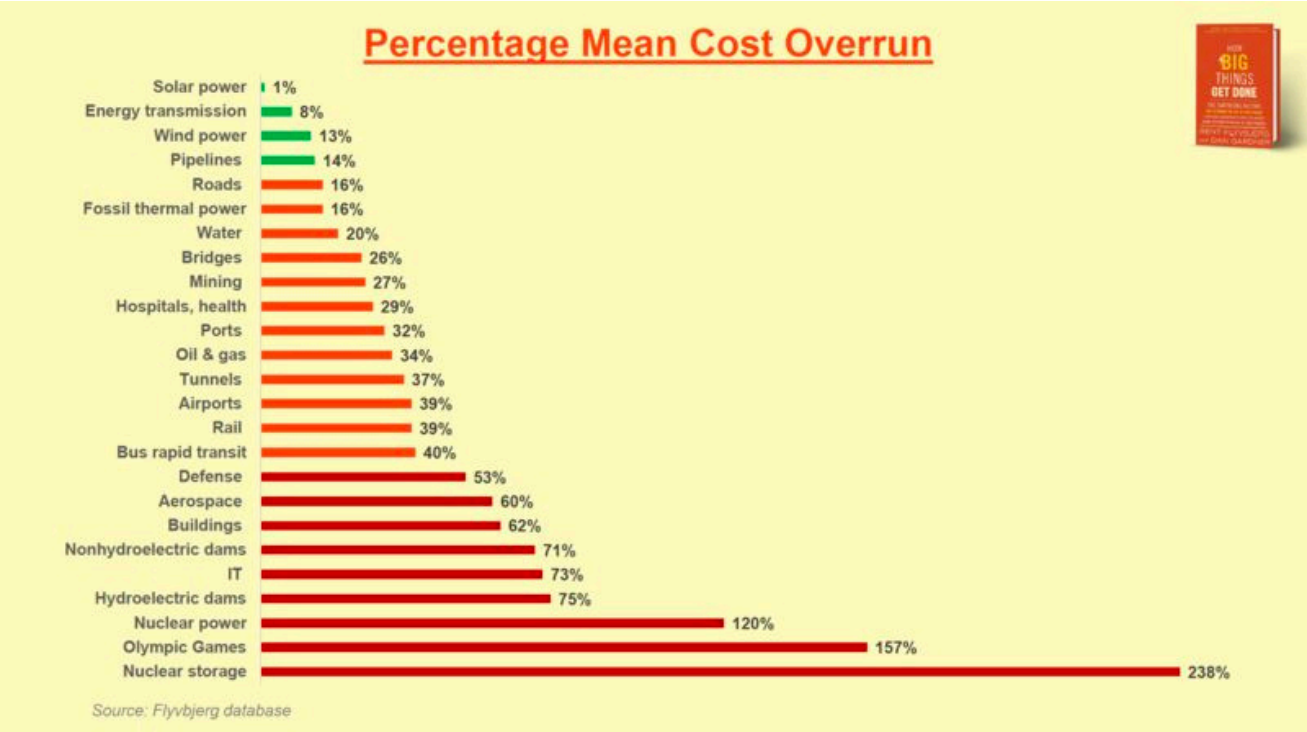
Note: Figures may not sum to totals, because of rounding.
[1]Base spending is calculated based on IHS Markit estimates. Net-zero-related spending is calculated based on McKinsey Global Institute forecasts, which assume that all net-zero capital expenditures in power, buildings, fossil fuels, and industry are directed to construction (but not to machinery or other physical assets).
Source: McKinsey analysis based on data from IHS Markit and McKinsey Global Institute

The opportunity to improve commissioning efficiency is therefore massive.

Even just a 1% improvement in project performance, which the application of commissioning best-practices can be a contributing factor, can result in $130 Billion in savings, which can be redirected to further infrastructure development benefiting society.

The complexity of projects, and therefore the complexity of commissioning, is a contributing factor to project under-performance.

This figure from Professor Bent Flyvbjerg's research shows project under-performance based on the type of project.



The Challenge

Projects with less modularity and repeatability, and therefore have more bespoke commissioning activities, consistently under-perform on cost objectives.

There has been no standardization across projects to guide groups undertaking projects on best-practices for commissioning.
This has led to inconsistent application of commissioning best-practices for proper project execution, and a general lack of understanding of commissioning across projects.

Improving commissioning best-practices on projects will come down to the understanding and adoption of a standardized approach to commissioning when planning new projects.

There is also a lack of experienced commissioning managers with a complete understanding of commissioning project management. Individuals in these roles typically come from personnel with field testing experience, or from personnel with construction project management experience.
But these skillsets are very different from the skillsets required for early commissioning planning and risk management.
With this commissioning project management skillset shortage, the industry is underprepared for the current volume of work on projects, let alone the projected volume of work over the next several decades.

The Challenge

Unfortunately, commissioning project management is not a discipline taught in any engineering, project management, or trades education programs.

The lack of education availability, skillset shortage, and non-standardized approach to commissioning, are contributing to poor project performance.

This has created a significant bottleneck for project teams to meet cost and schedule objectives when finishing projects. This bottleneck will continue, without a pipeline of new CxPMs with the knowledge of commissioning best-practices and the experience to guide project teams towards a successful finish.

The labour shortage, compounded by the lack of understanding of commissioning best-practices, makes it even more difficult to meet cost, schedule, and quality requirements of projects.

The Australia Constructors Association report titled: “Nailing Construction Productivity – a Blueprint for Reform” analyzes the construction market and has deemed it a failed industry with the following statement:

> “
> The wide range of opportunities seemingly available to dramatically lift construction [and therefore commissioning] productivity begs a

simple question: Why has the industry consistently failed to realise the promise of these solutions? The answer lies deep in the fundamentals of the construction industry – it fails to deliver the outcomes of a healthy competitive market because it is ultimately a failed market.

”

Friction between design and construction groups is one of the challenges raised in the McKinsey & Company report and the Australia Constructors Association report, and the same friction exists between commissioning groups, construction groups, engineering groups, procurement groups, and project management groups.

Friction between all groups working on projects is a symptom of misaligned incentives. All project groups must work more collaboratively and productively to improve project outcomes.

When commissioning groups are not involved in early stages of project planning, the divide between all groups becomes even wider.
When commissioning groups become involved much later after planning for design and construction is largely complete, all commissioning folks can do is identify issues that will be encountered during on-site testing due to misaligned decisions that were made earlier in the project.
When project teams fail to plan, they are planning to fail, especially for such a complex undertaking as project commissioning.

The two biggest challenges when it comes to project commissioning are therefore:

Lack of Early Engagement

Lack of early CxPM engagement to apply standardized commissioning best-practices in conjunction with design, procurement, and construction planning

Lack of Experience

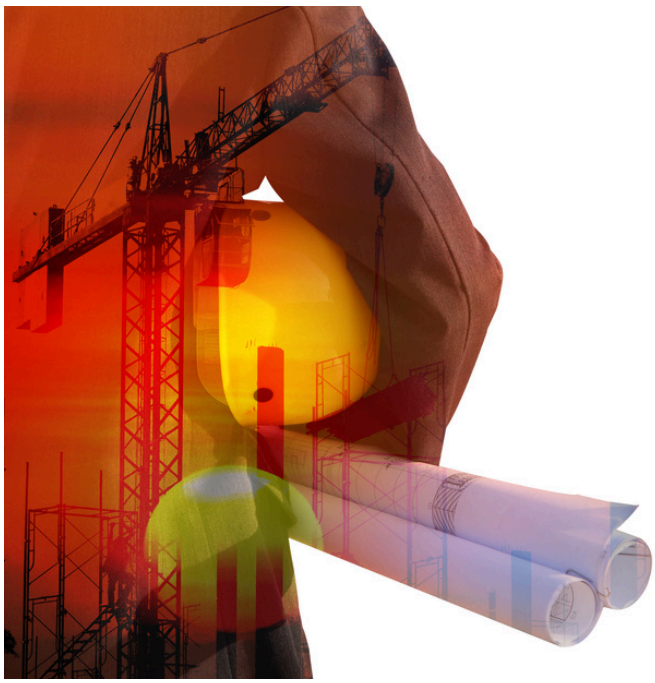
Lack of knowledgeable and experienced CxPMs to fulfill these critical early commissioning planning roles

Addressing these two commissioning challenges is a significant opportunity for improved project performance.

The Opportunity For More Efficient Project Completion

People deliver projects.
Even with the best processes to follow and the most advanced software tools to use, projects require knowledgeable and experienced people that are able to follow established processes and to put software tools to good use.

Projects are complex, and solving problems as they are encountered requires a complex thought process that no level of artificial intelligence can replicate at this point in time. These complex problem-solving roles on projects require a unique understanding of the situation to propose viable real-world solutions, and execute these solutions in the field.



For the longest time, commissioning folks have stated their need to be involved in projects from the start to plan for commissioning in conjunction with design and construction planning. Yet this often does not happen. Commissioning folks want to be part of the solution to improve project performance, but suggestions are often ignored and not taken seriously, costing projects much more later to rectify issues.

The Opportunity

There is a significant opportunity for commissioning groups to contribute to improved project performance, with minimal cost to projects.

By involving one or two key commissioning individuals much earlier in projects, project teams have achieved significant cost savings later in projects.
This is documented in many lessons learned gathered on projects that have taken this approach.
Many in the commissioning industry are worn-down and exhausted from raising these concerns in lessons learned over the years, with a feeling that they are not being listened to, and do not have a voice at the table.

When reviewing the McKinsey & Company report and the Australia Constructors Association report, the messages being conveyed by construction groups are very similar to the messages delivered by commissioning groups. So, there must be more complex issues at play, as to why there is a resistance to early commissioning engagement on projects. From the Australia Constructor Associations' report:

> "
> Linking construction's productivity problem to an entrenched resistance to change simply does not stand up to scrutiny. If a lack of appetite for new technology was all that is preventing the industry from realising a step-change in productivity, entrepreneurs would

> have displaced the old methods long ago. Yet Elon Musk has struggled to get traction with his Boring Company. The technology-driven building disruptor, Katerra, closed its doors after raising nearly $2 billion. No less than Thomas Edison failed in his own attempt to disrupt the home building industry through prefabrication. If capitalism has not yet solved construction's productivity problem, there is clearly more to the story than a simple-minded resistance to change.
>
> ”

Continued sharing of commissioning knowledge and expertise is essential, to re-engage discussions with project teams that want to improve both construction and commissioning performance, with collaboration from all groups on the known-solutions to apply commissioning best-practices.

Having more experienced CxPMs engaged early in projects is the best approach to help all project stakeholders understand and apply commissioning best-practices on projects.

When more people understand commissioning project management, and projects are able to be started with the end in mind, there is an opportunity to make an impact on the trajectory of projects to produce better outcomes.

Let's explore the steps required for early commissioning engagement.

What Are The Steps To Achieve Improved Project Completion

Construction groups are not able to improve project performance on their own, just like engineering groups, project management groups, or any other group working on projects will not be able to independently fix the broken construction industry. Improving project performance requires improved performance from all groups.

The single most impactful action that can be taken to improve commissioning performance on projects is by engaging input from experienced CxPMs much earlier in project lifecycles, at the same time as planning discussions are taking place for design and construction activities.

The actions required for increased CxPM engagement at the beginning of projects are:

Action #1 - Develop a global commissioning standard for industrial plant process/energy systems

While there are lots of resources and certifications to support the building commissioning industry, there are limited resources and support for industrial plant process/energy system commissioning. There is no global recognition or certification for CxPMs, and there is no global standard for industrial commissioning. While there are bits and pieces of standards that are referenced,

they are either proprietary internal processes used by large organizations, or lack the level of detail required to fully define commissioning best-practices.
A global commissioning standard for industrial plant process/energy system commissioning must be developed collaboratively with industry participation, and coordinated by an unbiased independent association, to establish the minimum standard for commissioning best-practices for industrial projects. The important aspect of this is that there is a baseline number of industry partners that accept and use this standard, as more companies will adopt to follow this standard as time progresses.
This does not mean standardizing testing. The valves to open and the breakers to close will always be project specific. But the project management methods to plan and manage commissioning must be standardized with the same risk-mitigating approach for a strong completion of projects.

Action #2 - Develop a certification program to certify experienced technical individuals to this global commissioning standard.

Once a global commissioning standard is developed, a program to certify individuals to this standard is required, as well as validation of years of experience individuals have worked with this standard. There are two important aspects of certification – knowledge and experience. Someone who studies the standard and passes the certification exam, and has 10+ years of experience applying this standard on projects, is much more valuable to projects that someone who has just achieved their certification and has less than a year of applied project experience. Certification must therefore have a

method to grant recognition of individuals who have years of experience with CxPM. This tracked experience must be direct commissioning project management experience; testing experience does not qualify, as this involves a different skillset.

Action #3 – Include contract requirements for CxPM engagement at the beginning of projects

Project owners must demand improved project performance and improved value for their investment. It can no longer be accepted that projects will be 20-30% over-budget, and that's just the way it is. Contracts must require that the necessary skillsets are available at the start of projects, with an experienced CxPM being one of the roles required at the beginning of projects. With a global commissioning standard, a certification program to certify individuals to this standard, and a requirement to engage CxPM early in projects, this ensures there will be a continuous pipeline of CxPMs with a baseline understanding of commissioning best-practices to fill these key leadership roles on projects.

Let's review the challenges with these next steps...

Barriers to Improving Project Performance with Commissioning Best-Practices

Of the three actions indicated in the previous section, establishing requirements in contracts for early CxPM engagement will take the longest to achieve. This requirement will take time to proliferate through the industry, as project owners see the results of improved project planning for commissioning.

Commissioning is complex, and change is hard.
Commissioning is not a discipline that is easily explained or easily understood.

The distinction between commissioning as a process to verify the intended outcome of a project, as opposed to testing equipment at the end of the project, is still not well understood.
Most people working on projects don’t want or need to understand the details of commissioning. But they do need to engage CxPM skillsets to help them plan for a strong project finish.

Civil challenges often overshadow the electrical/mechanical (E/M) challenges on projects. While civil challenges are being addressed by construction groups, planning for the end goal of projects - which is still successful commissioning and startup to meet the project in-service date – must continue, so everyone follows with the initial mindset to start with the end in mind.

Impactful change will not happen overnight.
It will take time as more people see the benefit of a global resource to establish the minimum standard for commissioning of industrial plant process/energy systems, as well as a pipeline of certified individuals to apply commissioning best-practices to projects.

Despite these barriers, we must continue to push forward if we are to improve the outcome of projects.

How to Overcome these Barriers

For those proactive project leadership teams that want to minimize risk and plan for a strong project finish, having access to global commissioning standards and a method to obtain certified CxPM resources will enable them to plan for project success.

But how do we get more project leadership teams to see the value of commissioning best-practices and the benefits that early CxPM involvement provides to projects?

The challenge is one of adaptation and proliferation. Until now, there has been no group advocating on behalf of the industrial commissioning industry for early CxPM involvement.
Discussions on early CxPM engagement remain at project-level discussions, with no larger industry-wide discussions taking place with all stakeholders.
More needs to be done at a higher level for awareness of CxPM best-practices and the value provided to projects, to improve project performance.

Strategic relationships need to be established amongst stakeholders with similar interests in improving project performance, such as the Major Projects Association (MPA), the Project Management Institute (PMI), and proactive construction associations taking steps for improved project performance such as the Australia Constructors Association (ACA).

Only with outreach and collaboration with other like-minded associations will the commissioning industry be part of the solution to improve project performance.

Next, let's focus on the path forward to establish global commissioning standards, create a consistent pipeline of certified CxPMs, and on building relationships with all project stakeholder associations for a better understanding of the value that commissioning provides to projects.

Recommendations and Next Steps

The following recommendations and next steps are required for the commissioning industry to contribute to improved project performance:

Recommendation #1

Establish a working group comprised of industry-partners to develop a global commissioning standard, that is developed collaboratively and is backed by industry experts as the baseline standard to achieve on projects for commissioning project management.

Recommendation #2

Develop certification criteria and a qualification program to certify individuals to the global commissioning standard, as well as implement a tracking system to endorse years of experience in a CxPM role.

Recommendation #3

Establish strategic partnerships with project stakeholder associations, to share information on commissioning best-practices, and to work collaboratively with these groups to improve project performance.

Conclusion

Commissioning of major capital projects is a complex process and is generally not well understood by many people working on projects.

Commissioning requires advance planning at the same time that design planning and construction planning take place, in order that all aspects of projects are coordinated efficiently.

Project teams therefore require an experienced CxPM at the beginning of projects to work with project managers, procurement managers, design managers, and construction managers, to ensure projects start with the end in mind for a strong project finish.

A global commissioning standard with a program to certify individuals to this standard is required to ensure there is a standardized and consistent approach to commissioning best-practices on projects, and a pipeline of commissioning mangers available to fulfill these early engagement roles.

Improved project performance will not happen overnight. Strategic relationships with like-minded industry associations will help relieve the friction between groups, and help slowly shift the perception of commissioning on projects, and how early CxPM involvement contributes to improved project performance.

The time to act is now. If you would like to participate, we invite companies to contact the Industrial Commissioning Association at info@icxa.net to see how you can become involved in supporting these initiatives.

Get In Touch

ICxA Industrial Commissioning Association

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