

Realising productivity construction delivery models

‘Implementing the construction
factory thinking’

#CE Nuclear Productivity Series
Volume 2



Foreword

By Chair of Nuclear Focus Group

I am pleased to see the release of our 2nd Volume in the productivity series that builds further on the arguments and ideas set out in volume 1 – Factory Thinking. This Volume provides thoughts and ideas on how it can be implemented into construction delivery models to gain productivity improvements. It is clearly a key area to support cost reduction. It is no silver bullet but will be the application of a new mind-set consistently and persistently across all elements of a pipeline of projects' lifecycles. This has been seen in the other industrial sectors with significant improvements realised.

It seems to me that the work we have been undertaking is starting to be recognised and the collective mind-set is changing at all levels within industry. It is supportive of recent initiatives and targets set out in the Industrial Strategy and Nuclear deal. Most dominantly of course, it includes cost reduction targets for both the new build power plants and decommissioning sectors.

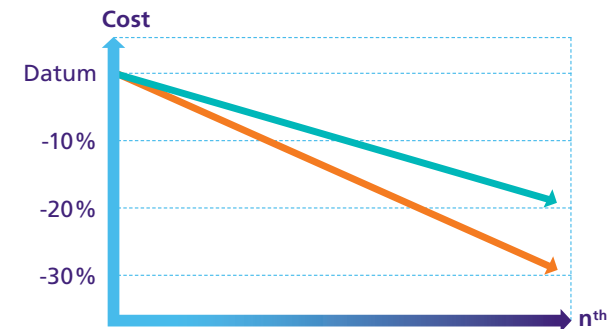
Most importantly, it is critical if we are to have a nuclear industry at all and this is becoming evident every day. So, if you're not on board yet, seriously, get on board now. Get involved and make a difference.

We have two more documents to follow covering procurement and digitalisation recognising the significance these can play and then we will be closing our work here and moving towards the impacts of disruptive technologies in nuclear construction projects. It will be fun.

Adrian J Worker

By lead author

When done right, the construction industry can bring a wealth of economic and social value to communities, industries and UK PLC as a whole. What we don't do well is learn from and improve upon best practice, continually learning and developing and using the mentality of the factory to look for waste and methods to remove it.



The more we look to learn and improve upon repetition, then the higher the likelihood of continual reduction in costs becomes. Building on our experiences is a key driver for the nuclear industry if we are serious about reducing capital costs by 30%. As the graph above looks to demonstrate, without this our goal becomes less likely to succeed.

What is highlighted in this document are proven models, methods and tools deployed across a range of construction projects and programmes. Currently, across the wider construction industry there are many exemplar projects highlighted by Constructing Excellence, the ICE, CIOB and a range of other industry bodies.

The industry has its burning platform today with new nuclear at risk of not happening and requiring a sustained approach by clients and their supply chain to demonstrate an improvement in productivity that improves outcomes and value for all parties involved.

Ben Pritchard



In order to make 30% productivity gains you will need the following

1. A culturally aligned integrated team with a common focus
2. Processes with defined roles but integrate the different disciplines
3. A digital approach but one that is usable by all
4. Good training and supervision
5. Challenging accepted (commercial) practices and a new approach to risk

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1. Introduction

Volume 1 provided a burning platform for change with insights into construction factory thinking and productivity. It proposed a construction delivery model to develop nuclear construction projects more efficiently. Volume 2 now expands upon Volume 1 and seeks to emphasise specific aspects of best practice construction delivery; make comment on some observations that hamper productivity; and, provide more information about how to gain a more productive environment for the nuclear construction project. In this Volume we look to drive productivity in all phases of the nuclear construction project by the removal of waste (non-value adding activities). Furthermore, we seek opportunities for greater efficiency and proactivity, by approaching the project lifecycle and placing productivity at the heart of the decision making process.

Central to construction factory thinking, clients, contractors, designers and manufacturers must learn to approach projects with a collaborative mind-set and productivity at its core. This is with each other and throughout the supply chain. It must explore all critical productivity drivers and will require a ruthless, systematic and consistent approach to delivery. Surprisingly, most projects take different approaches in resolving similar challenges missing the opportunity to improve productivity. There is usually insufficient collaboration with little time given to learning from previous or wider experiences to allow the development of a more comprehensive and efficient Project Delivery Model. Nuclear projects must be “right the first time” to be productive and this requires a delivery model to be focused and set up correctly – adapting through the lifecycle from inception through to completion.

The development of a Construction Delivery Model for nuclear projects, based on best practice and lessons learnt from a diverse set of projects, will inevitably help to enhance productivity and bring more certainty to delivery. The more consistency in the model, the more improvement can be achieved with associated benefits. This applies even to live nuclear construction projects despite the diversity within them. Throughout this document we explore this further using the lens of some of the most productive projects we have observed in the world. Whilst the considerations and recommendations set out in this document may seem intuitive, the body of evidence suggests that the more obvious lessons are the most difficult to change. Especially as a project progresses and gains momentum.

If this paper resonates with you and you are interested in better understanding the Nuclear Project Delivery Model, and you would like to get more involved and support development of initiatives that will have a positive impact on the industry, please get in touch at:

helpdesk@constructingexcellence.org.uk

and join the #CENuclear group.



2. The imperative – the burning platform – why change?

If our industry is to prosper, we must do things differently and demonstrate to Clients and the Government that we can provide value for money whether that be in New Build, operations or decommissioning.

Overall, a systematic and ruthlessly consistent approach to Nuclear Project Delivery is required. Surprisingly, every Nuclear project seems to take an independent approach to resolving these challenges without necessarily dedicating the time and resources to learning from previous experience or developing a comprehensive Project Delivery Model. Nuclear Projects must be “right the first time” and this requires the delivery model to be focused and set up correctly from the project’s inception through to its completion.

Clients pursuing nuclear projects are deploying various business and procurement models. Each of these approaches seek to engage a complex supply chain to undertake the design, construction and commissioning of a wide range of plant. Applications of commercial arrangements vary and are driven by client capabilities (existing and desired) including those required by nuclear regulation. They are frequently dictated by the risk clients choose to transfer to the supply chain rather than what will optimise the performance and value of the project.

In any model, the output is the same ‘a fully constructed ready for commissioning or a fully decommissioned and de-constructed nuclear facility’. The value adding activities, required to achieve either, are the same. These models are simply an organisational matter that must aim to be efficient and as productive as possible. Therefore, focusing on value adding activities, minimising non-productive activities and avoiding waste are crucial. They require the right environment and that is the responsibility of the client to create. The client must be capable of doing this, be brave enough to do so and show strong leadership. The supply chain needs to be responsive and be focused on achieving client visions and missions. Clients need viable and sustainable supply chains with deep expertise. These are mutual objectives that should be easily recognised and pursued.

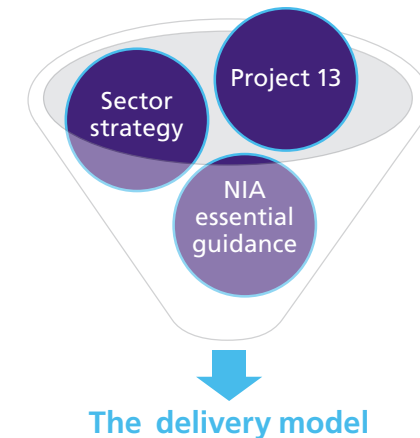
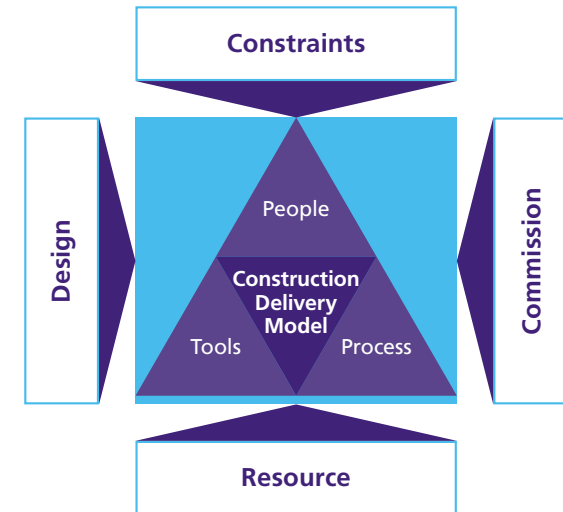


Figure 1

3. Observations that challenge current practice on nuclear construction projects

We consider here some of the practices observed and challenge ourselves as to the impact on productivity. To be clear, we are not saying these are wrong just challenging their appropriateness in relationship to delivery and productivity.



In a word...

WASTE!

Figure 2

EPC Contracting/ EPCM and other approaches

Developers look to offload all risk to contractors who in turn add a substantial risk premium to the price and look for the minimum compliance with design and quality.

Construction of joint ventures

A lack of integration culturally and not joining up processes, goals and outcomes can lead to repetition and waste through the duplication of effort. An approach centred around ISO44001 can help in the formation of JVs avoid this through clear designation of responsibilities and accountabilities with project teams and their respective organisations.

Separation of design, construction, completion and commissioning

With new parties entering at differing stages there is a need to review and verify and often negotiate where responsibility begins and ends. Is commissioning a consideration during design to ensure the most productive and efficient strategy is in place?

Construction planning – is this the first time?

Have you considered where else this work may have been done before and what can be learnt and embedded into your project?

Separation of civil, mechanical and electrical in design and construction

Design integration is a key step that if not undertaken and differing aspects of design are done in isolation it is more likely that when brought together the final solution is not optimal and does not encourage a productive environment.

Approaches to QA/QC – are these robust to ensure quality product on site

Are processes giving due consideration to what is required?

Treatment of risk

Do we consider who is best to manage risk or just how do we move risk away from ourselves?

Complicated commercial structures

Is the contract appropriate for the work? Does it give the opportunity to reward a highly productive approach to the work? Does it encourage the right behaviours? Does it allow contractors and their operatives to fully understand the clients objective?

Procurement process

Is the outcome of the project well understood? Are the business case outcomes embedded within the procurement process?

Use of manpower substitution

Do we best use manpower? Is there an automated process that could be implemented that would create a more productive and safer environment for construction projects?

Industrial strategy – what do we want from our industry

Are the aims of the industrial strategy well aligned to those of its clients, supply chain and regulators? Do we have a common goal that is well defined, understood and an integrated approach to its achievement which is clearly set out for industry to follow?

Regulatory impacts

Are regulatory considerations being used as an excuse to not do something new? Can we approach the project in an innovative or more productive manner?

4. Best practice observations that support high productivity

Constructing Excellence seeks, observes and promotes many best practices across the construction industry many of which relate to nuclear construction projects. In 2011, a group visited Japan to observe some of the practices used through the Japanese nuclear industry where, before the earthquake, they were pushing construction times down to 37 months from first nuclear concrete. Some observations made that might be considered are illustrated here.

Having clear robust strategies

The philosophy of the whole top to bottom process needs to be based around clear policy aims and strategic thinking to achieve high levels of integration and collaboration with the subsequent efficiency benefits – including high productivity.

Designing for construction

The design process includes construction and commissioning considerations. Designing simply for function and maintenance is not effective and will lead to non-productive sites. Take construction and commissioning into account at the beginning of the design life cycle not the end.

Integrating design

Design the whole, not just parts of; by integrated design elements e.g. civils and M&E. Outcome is simpler tidy designs that can be easily modularised and constructed (relatively).

Avoiding temporary structures

Seek to avoid temporary structures developing a priority on establishing the permanent structures that could include key site buildings, roads, sewage etc.

Plan and simulate

Don't rush into the build but plan it out and optimise sequencing. Simulate the construction process and optimise it before acting. Practice high challenge areas before reaching site if possible.

Constructing from inside out

Sequence the construction from inside out rather than outside in or stuffing. Access is better and likely to be more productive.

Modularising construction

Seek to modularise the design and therefore construction. Seek to do as little on site as possible and as much in controllable environment as possible. Quality improves as does productivity.

Collaborate (not a contract condition)

Collaboration is a big part of the Japanese mind-set and takes place despite contractual conditions. It was easy to see that collaboration is not a contractual condition but instead a state of mind that is driven to deliver high quality output and reinforce the relationship. We in the UK immediately look to the contract and this can quickly drive non-collaborative behaviours. This suggests another approach.

Top to bottom quality

There is a focus on quality at all stages from top to bottom and this probably reflects why safety was never at the forefront but always present.

Using common highly visible information

Using common information / data systems providing a 'centre of truth' in status, properly configured data etc. encourages trust and the ability to turn data into actionable knowledge in a quicker more efficient manner.

5. Creating a self-sustaining drive to improvement and productivity

Driving change towards productivity

There are many areas to tackle in seeking higher levels of productivity. Firstly, there must be an organisational desire from the top to improve, and time allowed for the process to be facilitated. Investment is necessary and must be based on return on investment (ROI) principles with appropriate prioritisation to a point where returns have significantly diminished, or time has run out.

An improvement process to drive productivity

A common well-established improvement process deployed across many industries is illustrated in Figure 3. It is a continuous process and can be applied to new challenges from the outset. The drive to understand the problem first is critical. Defining a solutions desired outcome is a key task to be undertaken at the earliest opportunity. It is important to challenge assumptions and preconceived ideas in testing possible solutions and defining outcomes.

The process embeds a tool set to facilitate discussion, enables priorities to be assessed, uses factual data (rather than anecdotal) and demands the collection of evidence to ensure that the expected outcomes are realised or adjusted to suit the ongoing learning process.

Highly trained experts to drive productivity

To accomplish this, an expert group must be established consisting of well-trained people, drawing on the most talented people from across the delivery team, to support productivity improvement and facilitate productivity workshops across an agreed and supported programme. The team must be able to operate at all levels of the entire delivery team, and be equipped with the essential tools. It will create a common language to tackle well defined challenges and a common tool-set.

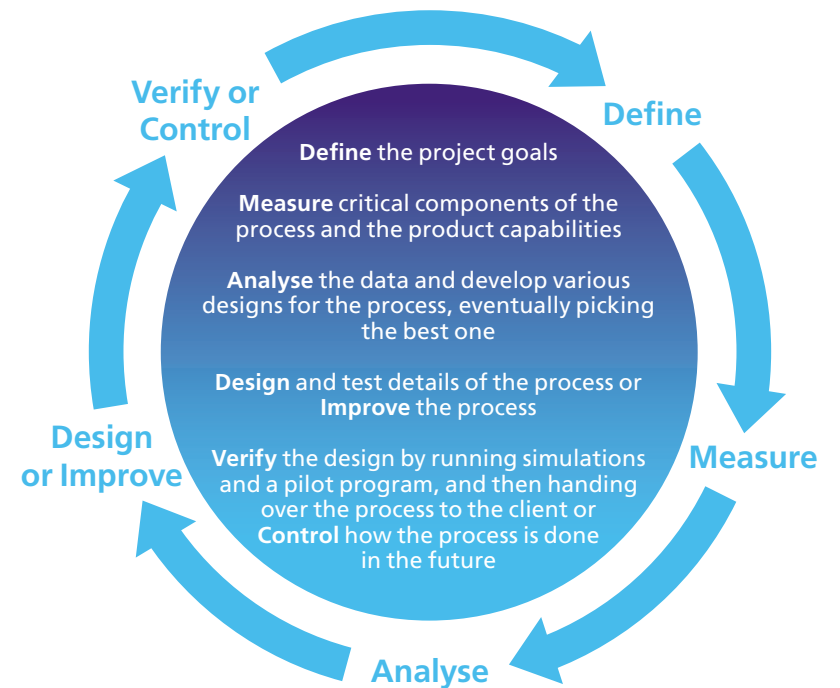


Figure 3



Figure 4

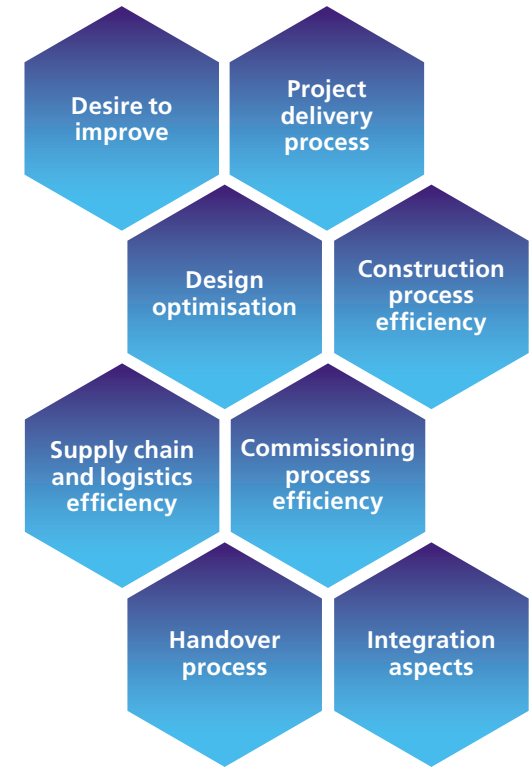
Previous learning
6 Sigma
Integration
Best Practice Models
Lean Integrated Project Delivery
Collaboration
Flow Modelling
Benchmarking
Supply chain design
Reliable Commitments – Planned percentage complete
Value Engineering/ Should costs
Standardisation
Vendor Managed Inventory
Decision Councils
Concurrent Engineering

Target areas to tackle for productivity

The areas to tackle are manyfold and need to be implemented in a way of doing normal business. Some of the key areas that can be addressed are illustrated in Figure 4. Productivity gains will be achieved through a combination of focusing on value creations, removing waste and inefficiency and then driving efficiency improvement through greater integration. Given the sheer scope of potential priorities that need to be established, low hanging fruits will be targeted initially, followed by the hard drive for better productivity.

Tools to use to support productive conversations

There are many tools that can be called upon to support productivity improvements. Many have been identified in Volume 1 as shown in Figure 5 and are further illustrated and explored here in Volume 2. Details can be found in the Nuclear task group page of the Constructing Excellence website.

**Figure 5**

6. Engaging in delivering a productive nuclear construction project

Engaging for productivity in process stages

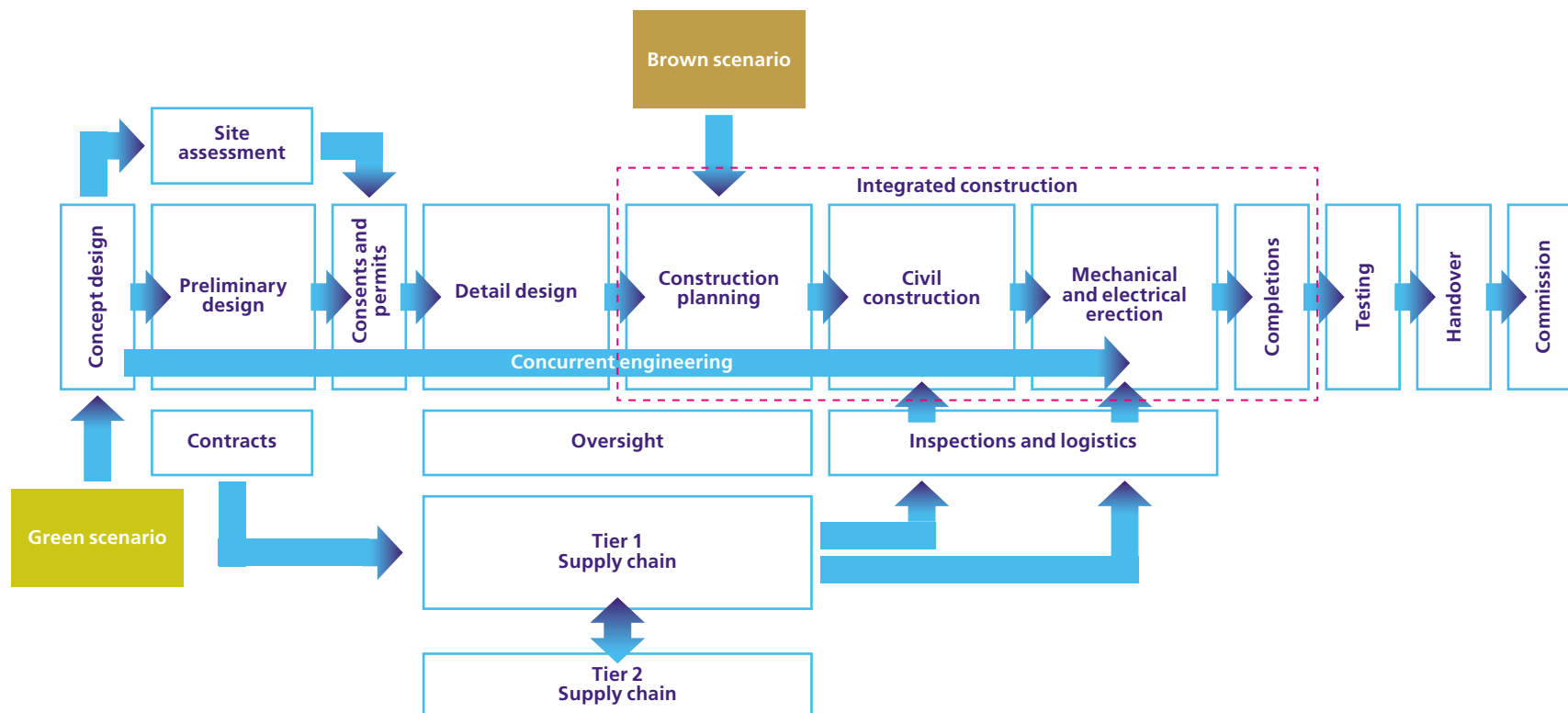
As described in Volume 1, productivity should be considered from the outset through the design and delivery using various well proven tools and methods that cover:

- high degrees of planning,
- examination and integration of detailed processes,
- metrics and measurements to ensure consistency.

Therefore, when we start designing infrastructure, facilities, plants or buildings in the context of a nuclear construction project, we need to think and take the same approach at the design stage or as soon as possible that is described as the 'Green Scenario' in Exhibit A.

In many cases constructors may be faced with a 'Brown Scenario' in which case approaches can be taken to drive more productivity recognising that there are many more constraints to consider. Thinking and driving productivity at the earliest stage will deliver enhanced productivity and benefits.

Exhibit A – Construction focused process



7. Implementing the productive nuclear construction delivery model

As highlighted in Volume 1, a key to successful delivery of a construction project is the deployment of a consistent, integrated and collaborative delivery model. This model is designed to drive a productive, committed and right-first-time culture for the entire lifecycle. Each nuclear construction project is undoubtedly and arguably unique however each one does have a large repetitive element. Many different features need to be considered and adapted to the specific needs of each project. This includes implementing best practice models using the approaches described earlier consistently and persistently. The models must include:

- Recognising differing regulatory regimes, technologies, processes (construction, operation or decommissioning) being required and using new supply chains. This is set within long time frames and consequently needs a systematic approach to aligning the many delivery organisations. It includes developers/owners, the entire supply chain serving the project, stakeholders all driving to work together with a simple goal in mind: delivery, on time and on budget, safely to the right quality.
- Having a clear meaningful vision, reinforced by a set of values to drive a productive project culture of commitment and delivery, and supported by a set of optimised lean delivery processes that are communicated with ruthless consistency by an Intelligent Client as part of its overarching integration function. The aim of a construction delivery model is to provide clarity of organisation, roles and responsibilities, decision-making, and provide the processes and procedures for delivery with a focus on customer service and capturing knowledge and lessons learned.
- Addressing organisational and project health. (This is often overlooked by most project leadership and client organisations as standard “project management”.) A project already has a major advantage over other types of operating organisations – it has an ever visible and clear goal of delivery. However, “project management” as a theory or in practice, misses the critical and complex aspects of successful nuclear projects. It assumes that lower levels of the delivery team that are typically responsible for basic project management are equipped to deliver the strategic overall goals of a massive scope of work with traditional and conventional approaches. In the context of a successful nuclear project, the singular role of the senior leadership team needs to be flawless execution of each phase of the project in the context of a wider programme that supports delivery. To achieve this is to appreciate the interdependency of each phase and therefore the need for integration and the management of the interfaces by the leadership team.

It is hoped that a common set of success measures, benchmarks and standards will evolve for nuclear projects to enable learning across the industry. Constructing Excellence will continue to develop this area with clients, industry stakeholders and other bodies through the further development of the Productivity in Nuclear Construction Series of papers.

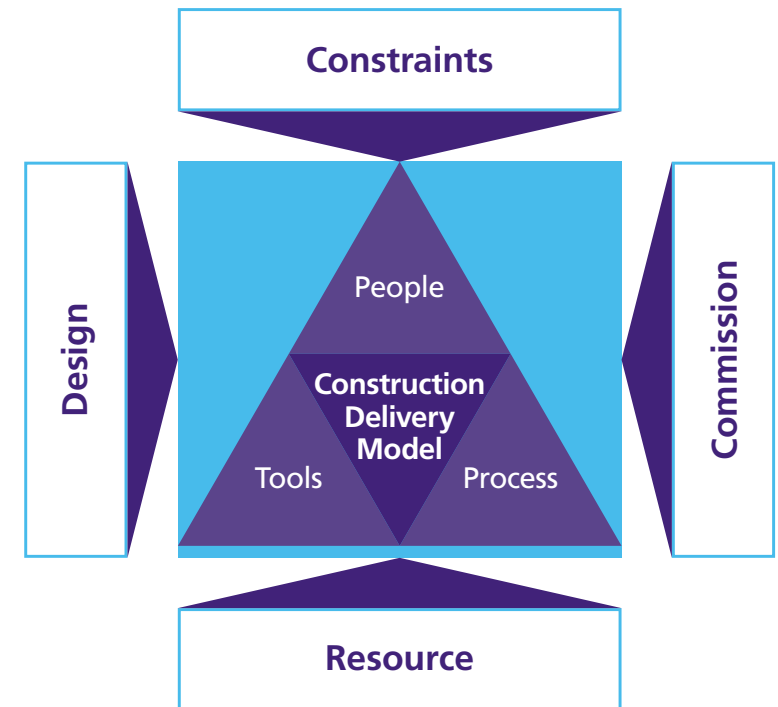


Figure 6

The critical leadership role of the client in enabling productivity

Strong senior leadership of a construction project is necessary to support delivery and needs to be propagated from the very top of the Client organisation. Specifically, developing a clear Vision for the entire Project with a supporting set of appropriate delivery-focused values is key at the project's inception. To maximize value and uptake across the Project, the vision, the values and the project culture cannot be delegated, outsourced or disconnected from the senior leadership team.

The Institution of Civil Engineers has developed "Intelligent Client Capability Framework" (ICCF) in which it provides an approach to building up the skills for the Client. As shown in Figure 7.

The ICCF outlines the necessary skills in terms of beneficial behaviours and abilities conducive to successful delivery of major projects or programme outcomes. ICCF is a simple and effective tool that can help clients benchmark their internal culture and processes.

It assists members in identifying areas for potential development and provides a structured means of self-assessment, allowing members to reflect on their own capability and identify areas for improvement and the incorporation of good practice.

This has been further built upon within the recently published Project 13.

Our commercial delivery model required to optimise productivity on a nuclear construction project is well aligned with the Project 13 enterprise model. Common to both is the need for an integrated organisation, aligned and commercially incentivised to deliver better outcomes for the client, its customers and its investors.



Figure 7

Project 13 has a range of case studies that demonstrate the benefit of a better way of working together both across disciplines and across the supply chain. The attached diagram shows the lessons from Project 13 needed to create greater value on future nuclear projects.

The embedment of outcomes such as a highly productive project are key to its overall success. It is incumbent on the client to embrace at the earliest possible opportunity this way of thinking to ensure that it is embedded throughout the supply chain and thereby integrate and align the design, construction and operational phases. With the integrator in place and well informed of the outcomes, a number of the issues identified in section 3 can be avoided. The holistic viewpoint, well incentivised and digitally enabled can support the creation of a highly productive environment.

Volume 3 which focuses upon procuring for productivity will expand further upon our thinking and the importance of the integrator role.

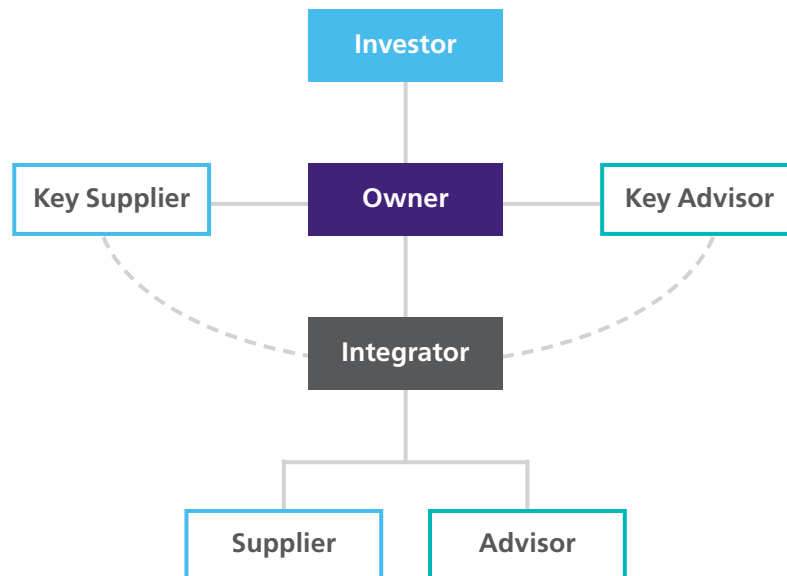


Figure 8



Planning for 'organisational change' during construction project delivery

The roles and responsibilities and, demands required to deliver a nuclear construction project over a long timescale change throughout the lifecycle. Roles and responsibilities need to be established parallel to the development of a fit-for-purpose organisational structure. There needs to be clear understanding that a nuclear project delivery organisation is dynamic. It is a very different organisational type relative to a static operating environment or a less complex construction project. It constantly will need to evolve to suit the specific needs throughout the life cycle.

Specifically, the skill-set and competencies of senior leadership need to shift as the project moves through the delivery phases and a digitally enabled process allows for a much greater and holistic approach to construction.

Initially, project establishment, planning and initiation will be key skills required by client organisations and provide investment and regulatory confidence. Ultimately Construction, Commissioning, and Operations skills are required.

At no point in the nuclear construction project lifecycle, until operational, can the organisation "stabilise" due to the dynamic nature of the project environment. This should be managed through early preparation and planning to ensure a smooth start and transition between lifecycle phases. An Intelligent Client supported by their overarching integration function and strong human resources, competency assessment and knowledge management functions need to take responsibility to plan this phased approach.

This implies that there must be several iterations of senior leadership teams with the appropriate skills to deliver a given phase of the project. Roles and responsibilities will need to be updated accordingly, along with their associated decision-making and delegations of authority.

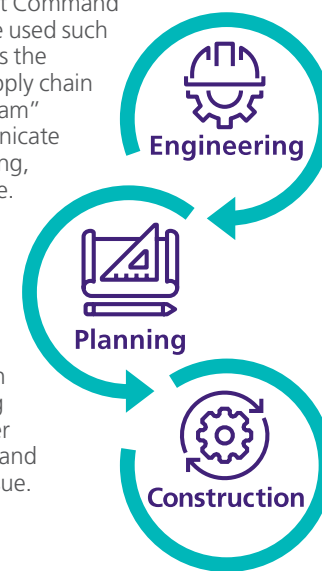
Additionally, a fit-for-purpose developer/owner organisation must be able to operate as a "lean" client in nuclear construction driven by their safety culture, intelligent customer and design authority aspects.

Ultimately, developers/owners experience all the risk and therefore must be appropriately staffed to act appropriately and contain all the necessary leadership and delivery skills that this entails.

Effective communication and command that support productive workforce

The establishment of an effective common shared communications and IT / information sharing platform across the entire nuclear construction project are essential. Investment in collaboration tools across command centres that operate and control the construction process 24/7 will lead to improved efficiency, productivity that is beneficial to the developer/owner, supply chain and stakeholders. In addition to collaboration tools, command centre structures can be used to support strong change control and decentralise decision-making, ensuring that decisions can be taken at the lowest possible level but with the support of other functions that may be impacted across the Project.

Additionally, the Project Command Centre structure can be used such that all the teams across the Nuclear Project and supply chain feel like part of "one team" and are able to communicate effectively, share learning, and transfer knowledge. The structure (Figure 9) provides complete integration: one set of the truth in terms of tracking packages of work as they move through the production process, understanding interfaces and handover points, and prioritising and managing emerging issue.



Seamless Integration of all Project functions and Supply Chain through Collaborative 24-7 Project Command Centre Capabilities

Figure 9

Having effective and empowered decision making is critical to achieving high productivity

High productivity needs rapid decision making either delegated to the lowest possible level to empowered individuals or a process of fast responsive organisational decision making to avoid inefficiency, delay or even stoppage.

Considering the magnitude and consequences of failure, and the need to deliver right first time, securing and developing the most talented, competent and experienced leadership team available across the international marketplace should be emphasised. Specifically, previous nuclear construction experience across the senior leadership team has been demonstrated to strongly predict nuclear project success. External leadership and organisational consultancy services can support and inform the development and streamlining of the organisation and may be periodically required to consider optimisation initiatives implemented by the senior leadership team.

Effective supervision and control

An often overlooked aspect of construction delivery is the implementation of effective supervision and control. Often, we find ourselves with too much or too little supervision, or at times individuals who may not be best suited for the particular role and the particular project.

Effective supervision is a key enabler for improving productivity. A well run and well managed site can see drastic improvement in their productivity.

Key to this will be ensuring that the supervisory team are well trained in the skill set required for effective supervision. Supervisors should be well versed on the project scope, what is required and how to effectively lead the team in a safe and productive manner to discharge the required outcomes.

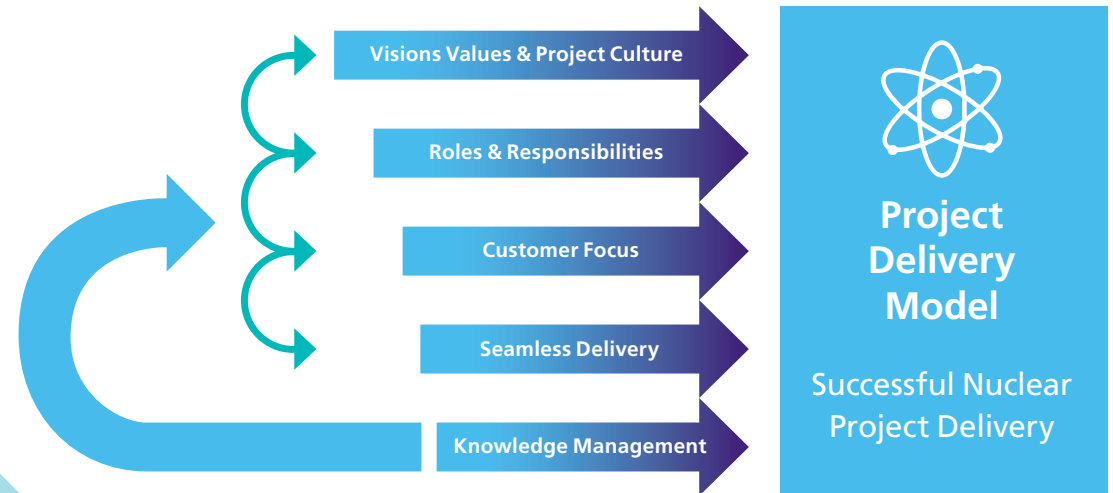


Figure 10

8. Establishing a culture of productivity and commitment

Promoting strong leadership drives productivity

Strong senior leadership is necessary to gain high productivity in delivery. It needs to be propagated from the very top of the client organisation. Specifically, developing a clear vision for the entire project with a supporting set of appropriate delivery-focused values is key at the project's inception. To maximise value and uptake across the project, the vision, values and project culture cannot be delegated, outsourced or disconnected from the senior leadership team. They must be owned and continually demonstrated. The touchstone in all aspects of the project, therefore needs to be current, appropriate and right.

Safety and quality are paramount. However, there is a distinction between safety culture and project culture both of which are key to productivity and are complementary. Both require individuals to be responsible but acting to a common purpose. A well run project has an exemplary safety record as an outcome. Safety culture focuses on a heightened awareness of the wellbeing of the individual and the team. Whereas project culture is focused on delivering results right first time in dynamic and fast-moving environments.

There is a strong emphasis on on-time and on-budget delivery creating a schedule-focused tension internally and across the supply chain. The schedule essentially drives the construction project and decision-making, resources, and all supporting functions need to be aligned and committed to this approach, ready to provide whatever support is necessary to maintain the project schedule.

Setting a meaningful vision

A Vision for the project needs to be established through broad consultation with all stakeholders and take a safety, quality and cost-conscious approach that can be easily communicated and understood by everyone across the project organisation and external stakeholders. The Vision needs to engage the full community. Although this document is dedicated to delivering productivity, the vision and its wider team have a duty to the community that they are serving.

The Vision needs to establish the goal of the Project and emphasise delivery of that goal. All internal and external stakeholders need to be clear on the vision and values and be personally committed to living the construction project culture every day. The vision needs to be supported by measurable goals and be critical to success. These are often recognised as critical success factors. Included in these should be productivity measures.

In essence we are looking for that JFK moment when the NASA's cleaner's response to the President's question of his role was that he was helping put a man on the moon. Mark Zuckerberg of Facebook built on this when he said *"Purpose is that sense that we are part of something bigger than ourselves, that we are needed, that we have something better ahead to work for."*

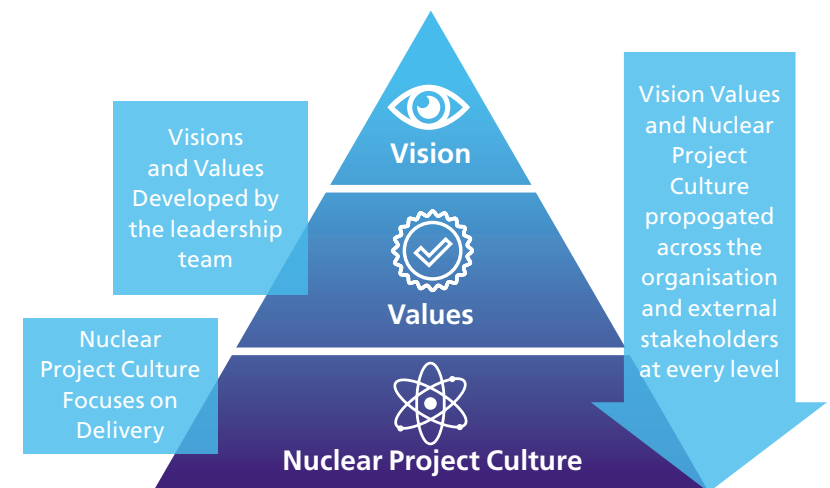


Figure 11



Setting aspirational values that recognise productivity and commitment

To support the vision, a set of values should be developed that ensure that everyone in the organisation behaves and communicates appropriately while working as one integrated team. Together, the vision and values provide a framework for the establishment of a high performing culture. Values usually affecting productive and delivery certainty include various best practices e.g. safe working open and inclusive selection, diversity, data informing, benchmarking, programming and planning, decision making, and collectively recognising and rewarding milestones.

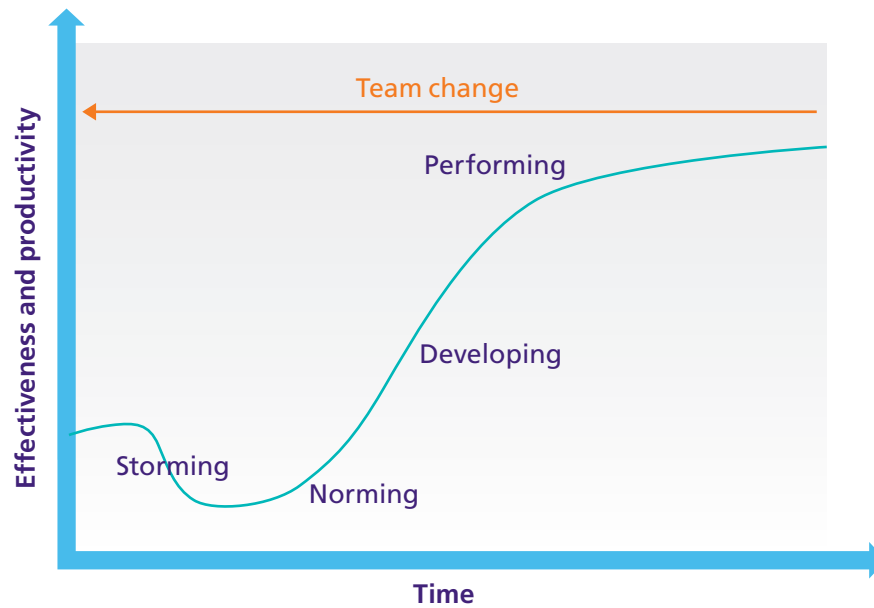


Figure 12

Accessing and developing talent and skills

Successful construction teams can be mobilised quickly but are drawn through careful selection with consideration for the fit and who is the right person for each role. Each separate organisation may do this, but when brought together the sweet spot of the right skills, knowledge and attitude can often be missed. Teams take time to build and need investment. Integrated teams more so recognising optimisation of construction delivery and productivity of a project requires strong collaboration by all parties with trust embedded in the process. The entire team, client and supply chain should understand and recognise each other's strengths and weaknesses.

High-performance teams outperform all other similar teams and they outperform expectations given their composition. A high performing team typically has:

- Participative leadership
- Effective decision-making
- Open and clear communication
- Valued diversity
- Mutual trust
- Effective ways to manage conflict
- Defined and measurable goals
- Defined roles and responsibilities with recognition of own and collective responsibility

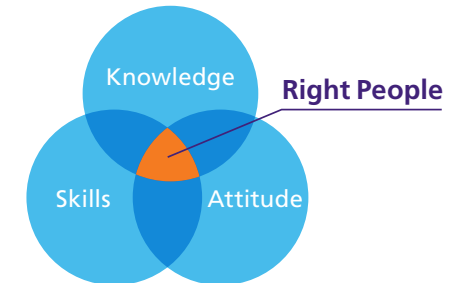


Figure 13

Achieving these levels requires coaching by experts that support the leadership. Consistency of team membership is a priority but inevitably new members need to be introduced. Mechanisms need to be prepared that facilitate this and avoid damaging the overall effectiveness of the team. Therefore, choose wisely initially, invest in and have measures that can show effectiveness and productivity.

9. Enabling supply chains to be productive and committed

Procurement sets the scene and establishes the tone of the project. It is essential therefore that it is an integral part of the project cycle and not a standalone activity conducted by a team independent of the project. The procurement process acts as an enabler in assembling a reliable supply chain focused on productivity. Currently most procurement approaches do not consider or address productivity. The trend is to identify collaboration as a mechanism to unearth innovation which leads to better value. Competition is seen as a way of accentuating these criteria. However when demand and supply are on a knife edge and margins are small, supply chains are more selective. Therefore the nuclear client needs to be progressive in linking procurement, innovation, collaboration, productivity and added value. These mechanisms and outcomes need to be harnessed so as to counter the issue of establishing the right skill-sets.

Therefore in summary procurement needs to embrace:

- Alignment of goals
- Focus on high productivity mechanisms
- Delivery of quality goods
- Efficient and minimal interfaces
- Value added rewards
- Well managed and apportioned risk
- Early engagement with the entire supply chain
- Behaviour models
- Constructive challenge
- Innovation

Key is the need for practical collaboration in programming with multiple workstreams, e.g. mechanical, electrical, civil and specialist areas, simultaneously requiring access to the same construction areas demanding efficient sequencing, integration and elaborate planning.

Procuring for productivity is to be addressed in more detail in a volume 3.



When we discuss digitalisation it is easy to focus on BIM and to get lost discussing 3D, 4D, 5D models, level 1, 2 and a plethora of technical terminology that many will not fully understand.

We must not forget that there is an abundance of digital tools that can further augment 'digital engineering' that focus upon improving productivity, quality, collaboration, contract management and most other aspects of the construction process. We need to ensure that the industry considers the interoperability of these systems and embraces them whilst ensuring the behavioral step change required to ensure their optimal use is also embraced. A digital solution after all is only as good as those who use it.

The concept of building digital first can help reduce the impact upon cost and programme of any unforeseen requirements during the construction and operational phase of the project. The digital platform acts as a secure virtual space where all project data is correlated and housed. The result is greater accuracy, collaborative working and, importantly, far less wasted expenditure at the build stage.

However, the digital platform is just the start when undertaking a nuclear construction project. A nuclear facility is a long-term asset, and effective maintenance is paramount to ensure it remains safe, efficient and accessible throughout its lifecycle.

Digital tools can support the establishment of early engagement with the supply chain, integrating all aspects of the design in a single coherent location that allows a holistic approach to the construction project ensuring no integration issues either in system design or programme development.

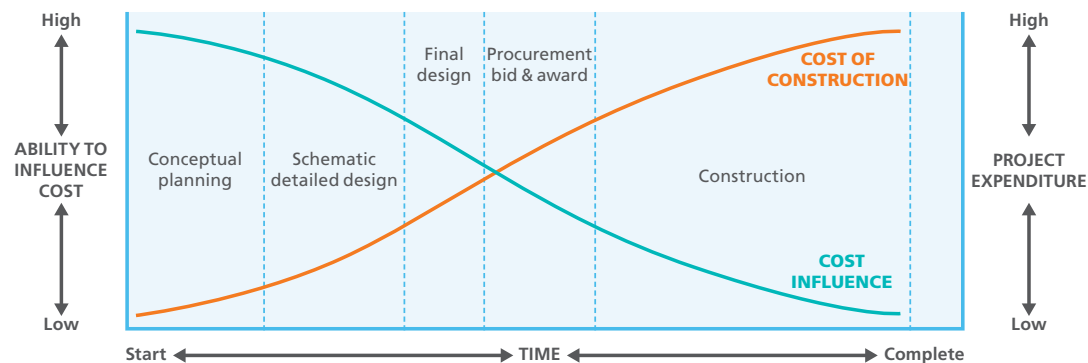
When BIM is interfaced with product lifecycle management at the very start of a project, it provides a fully digital solution that supports feasibility and planning, design and development, construction, operations, maintenance and decommissioning phases of an asset. This combination is known as project lifecycle management (PLM).

Evidence of the success of this method is already out there to see. GE Hitachi Nuclear Energy and Exelon Generation's industrial internet platform project is using the latest analytics and sensor technology to optimise plant maintenance and increase asset life. This case study outlines benefits that include \$230 million of savings for a new combined-cycle gas power plant, as well as up to \$50 million of savings for an existing plant. Across the industry today, this would equate to around \$75 billion in savings.

The UK construction, nuclear and power industries have been guilty of being behind the curve in deploying evolving digital technologies. Now is the time to recognise exactly what can be achieved by embracing them.

Volume 4 of this series will expand upon the use of digital platforms in the Nuclear industry and how they can be utilized to drive a highly productive construction project.

Figure 14
COST INFLUENCE CURVE



10. Summary and Conclusions

The Construction Delivery Model discussed in this document challenges the fundamental approach to establishing a fit-for-purpose Project organisation and the appropriate level of organisational integration that is required to maximise productivity.

Using the construction factory thinking model will allow for a systematic approach to delivery that will reduce risks and uncertainties and support the delivery of Nuclear Projects, on time and on budget, safely and to the right quality.

There are a range of excellent tools, best practice principles and learning that can be shared with you from the Constructing Excellence database that demonstrates how an improved approach to project delivery can not only achieve but exceed the expected return on projects from a range of differing sectors within the industry.

Achieving highly productive projects will be a challenge for the industry, but with the tools and process described here, along with the ideology of the construction factory set out in volume 1 we hope we are providing the key ingredients required to delight clients and be recognized for world class productivity.

Key points to take away:

- Productivity is required to be considered in the conceptual planning and to be part of business case, procurement and development of the delivery model
- Planning and communicating to all parts of the project are key with a strong vision and mission well understood and embraced by all parties
- The client has a key role in enabling the development of a productive environment for project delivery
- If we are to achieve our target of a 30% reduction in capital costs, productivity improvements are key
- Productivity is the responsibility of all organisations and individuals associated with the lifecycle of a nuclear asset



In order to make 30% productivity gains you will need the following

1. A culturally aligned integrated team with a common focus
2. Processes with defined roles but integrate the different disciplines
3. A digital approach but one that is usable by all
4. Good training and supervision
5. Challenging accepted (commercial) practices and a new approach to risk

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