Modern Methods of Construction: A briefing for buildings, highways and environment

GallifordTry

Jennie Hughes 2022

MMC: an introduction

1) informative piece

2) to give overview of MMC categories

3) examples of use in GT

Contents:

Blackridge: a Passivhaus school by Morrison Construction

Introduction

What is MMC?

MMC is a broad term that relates to any pre-construction or construction technique that benefits the design and cost without reducing quality.

It is very common for offsite, MMC and DfMA (design for manufacture and assembly) to be thought of as interchangeable words that mean modular builds however, this really isn't the case:

- MMC techniques can be either **onsite** or **offsite**, and are the tools with which we deliver **DfMA**
- **DfMA** is the name of the strategy that focuses on the concept of MMC
- **Offsite** is a type of MMC

Almost all offsite techniques are MMC, but not all MMC is offsite.

Common MMC examples

3D-volumetric
Flat slabs
iFAST
CLT
Precast panels
Brick-slip
MetFrame
iSIP
Cladding panels

PCC
Precast foundations
Robotics
Pods
Offsite-AHU
Braced Pairs
Exoskeletons
Modular gantries
Digital design platforms

Why is MMC relevant to Galliford Try?

- Client led - many of our clients across all sectors have MMC targets, including PMV.
- Government drive to increase standardisation as has been witnessed in recent framework bids.
- Opportunities to improve onsite Health & safety, programme adherence & to support sustainability goals.
- Remain competitive, addressing the construction workforce shortages.
- Construction Playbook has prioritised platform designs and other MMC techniques over traditional methods

How do we encourage adoption?

We currently have a database of over 160 examples of GT projects that have utilised modern methods of construction: with 6 out of the 7 MMC categories (as defined by the government) being covered.

MMC techniques will not be appropriate for all elements of all projects, but we want to ensure that we are equipped with the knowledge to identify early on where, and if, we can utilise these practices.

Farmer Report

October 2016

Modernise or Die

In 2016 Mark Farmer released a report called “Modernise or Die”. This was “commissioned by CLC in response to concerns that productivity and capacity in the construction sector are undermined by its reliance on subcontracted labour, and low levels of investment in skills and innovation”.

Industry problems

Climate change causing change in client drivers

Carbon reduction necessity

Declining workforce

Resource scarcity

Price volatility

Safety issues

Quality issues

Reports conclusion

Farmer concluded that the construction industry has a limited time to address its weaknesses by the adoption of modern methods of construction. He stated that main contractors and their supply chains have approximately 10 years (from 2016) to address the issue.

MMC Categories

The government released a document detailing the 7 types of MMC within construction (Modern Methods of Construction: introducing the MMC definition framework)

MMC Category Overview	Category 1 3D load bearing structural elements. Can be structure only or fully fitted out internally or anywhere in-between e.g. volumetric solutions, pods (if load bearing)	Category 2 2D load bearing structural elements. Can be open structural panels or fully fitted out and finished or anywhere in between e.g. SIPs panels, Pre-cast concrete panels, panelised lightweight steel frame	Category 3 Pre-manufactured structural component. Individual structural elements are delivered individually and erected on site. e.g. cold or hot rolled steel frames/slabs, timber frames, pre-cast concrete frames/slabs/stairs/cores, braced pairs
Category 4 3D printing of materials either on or off site e.g. printing components, or even larger elements such as stairs,.	Category 5 3D or 2D non-structural prefabricated solutions. e.g. cladding, SFS panels, bathroom pods, plant room/riser/corridor MEP modules	Category 6 Non-structural prefabricated component solutions to reduce site labour or improve productivity. e.g. brick slips, roof sheeting, SFS and drylining systems	Category 7 Process-led solutions to reduce site labour or improve productivity. e.g. exoskeletons, robotics, drones

Benefits

Meeting client needs - Many of our clients and frameworks are requiring us to prove our expertise in delivering MMC techniques, so by increasing our portfolio of successfully delivered MMC solutions we are meeting our client drivers and remaining a competitive main contractor.

Quality control - Greater control over production of the components leading to fewer defects.

Predictability - Work on the components can be better planned due to less relatable variables.

Health and safety

- Not subjected to poor weather conditions
- Reduced chance of working at height

Reduced disruption on site - By taking a large bulk of work offsite, disruption onsite is reduced. This especially benefits projects that are building on a live site.

Environment and Sustainability:

- Site noise and dust reduction
- Reduced on-site waste
- Often there are fewer thermal breaks with techniques from categories 1-5.

Challenges

Unprepared Supply Chain - We need to adapt and prepare our supply chain to be able to effectively deal with the increase in MMC techniques.

Early Design Freeze - Due to the altered design process when you use some MMC techniques, design freeze comes much earlier in the process. However, by achieving design freeze sooner, there is a greater chance of cost certainty which is beneficial both for the main contractor and of course for the client.

Not always suitable - MMC techniques are not to replace out traditional methods as they will not be suitable for some.

Longer lead in and upfront costs - Due to the differences in the design process and the need to have MMC techniques secured early on, there is a longer lead in on the programme and costs accrued earlier.

Quality checks - We need to create a system to monitor and ensure the quality of components / modules being made offsite.

Design accountability - When engaging with MMC subcontractors we need a clear understanding of what part of the design different parties are responsible for. We need better agreements with our suppliers (perhaps centrally) so design responsibility is clear.

Design interfaces –The compliance of component interfaces needs to be addressed so both us and the client are satisfied that all regulations are being met.

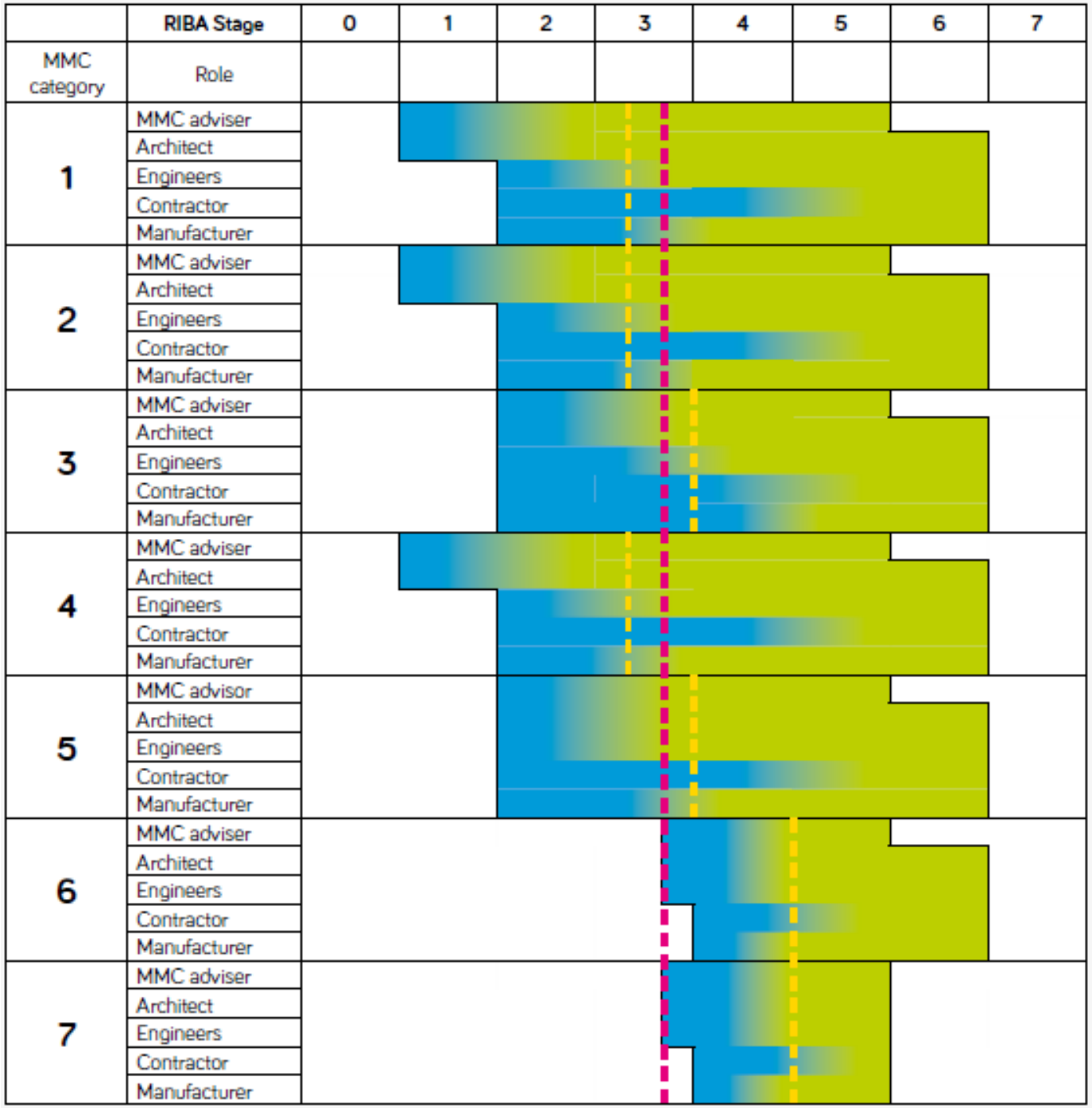
Fabric First

Whether for a new build or a refurbishment, the fabric first approach that is inherent in MMC can help us drive the changes that we need to meet these challenges and ensure that MMC will be central to the future of industry going forward.

Procurement

Traditional procurement routes have not always fitted well with off-site construction. Early contractor involvement is key as well as maintaining a collaborative working style. This is necessary to achieve design freeze at an early date to allow for co-ordination and the manufacture of components part of challenges.

Design for Manufacture and Assembly Overlay to the RIBA Plan of Work (page 40)



Key

Blue: recommended involvement / appointment of MMC members of the project team (from earliest to latest)

Green: typical duration of different parties' appointments

Red dotted line: usual planning application

Yellow dotted line: design freeze required

Multi-sector work stages

A comparison

Work Stages

	Buildings	Highways	Railway
0	Strategic Definition	Strategy, shaping and prioritisation	N/A
1	Preparation and Briefing	Option Identification	Output Definition
2	Concept Design	Option Selection	Pre-feasibility
3	Spatial Coordination	Preliminary Design	Option Selection
4	Technical Design	Statutory Procedures and Powers	Single Option Selection
5	Manufacturing and Construction	Construction Preparation	Detailed Design
6	Handover	Construction, Commissioning and Handover	Construction Test and Commission
7	Use	Closeout	Scheme Hand Back
8	N/A	N/A	Project Close Out

Category 1: 3D Primary Structural Systems

What is MMC category 1: Often referred to as volumetric or modular, this is a systemised approach involving the production of three-dimensional units in controlled conditions prior to installation. These units are then brought to site, stacked and then connected.

Volumetric units

- Volumetric modules
- Structural chassis (not fitted and internal fit out)
- Structural chassis with fit out and external cladding/roofing complete
- Structural podded room assemblies (bathrooms, kitchens etc)

Case Study: Newcastle University, Park View Residences

1,261 en-suite study bedrooms have been created alongside 10 studio apartments, across six blocks of varying height, as well as an energy centre and landscaping.

Methods used: 800 prefabricated containers, imported from China. Stacked in a cruciform lay-out, the containers included the bedrooms, kitchens and corridors attached to a core constructed in-situ and a traditional façade.

Time saving: the scheme was delivered in a little under two years, compared to an estimated three-year build time if traditional construction methods had been utilised.

Park View Residences [Galileo}

MMC Category 1 Examples			
Project	**BU**	**Sector**	**MMC technique used**
David Russell Halls	Scotland NE	Higher Education	Volumetric modules
RAF SLA	East Mids.	MoD	Module accommodation
Bathing Water Enhancement	Water	Water	CSO manufactured offsite
Park View residences	NE & Yorkshire	Higher Education	Volumetric modules

Highways Spotlight

- Evidence of using modern methods of construction that sit in categories 1, 3 and 7
- National Highways state that from 2023 offsite manufacturing will become the default method of design (where appropriate)
- Framework commitment 45: GT Highways have committed to investigate and review DfMA options on all projects where such techniques will increase productivity.

Category 2: 2D Primary Structure Systems

What is MMC category 2: a systemised approach using flat panels units for the load-bearing floors, walls and roof structures of a building. These units would be manufactured off-site, delivered as individual "2D" components and erected on site to form a "3D" structure, a flat pack of sorts.

Category 2 examples

- CLT panel
- iSIP: structural insulated Panel
- Panelised SFS: structural frame system

Case Study: Bishop Chavasse Primary School

Bishop Chavasse is a 2FE Primary School, located in Tonbridge in Kent.

Methods used: the Innovare i-SIP System, which formed the External Walls, Upper Floors and Roof. The external walls where a closed SIP, including insulation.

Programme and cost: a largely similar programme and cost profile as a more traditional (steel frame and PPC Plank) construction.

Bishop Chavasse School (Education presentation)

MMC Category 2 Examples			
Project	**BU**	**Sector**	**MMC technique used**
East India Docks: Anchorage House	London and SE	Commercial	Cross laminated timber
Merchants & Venturers	WM & SW	Education	i-SIP Full Structure
Great Field, Poundbury	WM & SW	Residential	MetFrame
Fraserburgh Health Centre	Scotland NE	Healthcare	Timber Kit

Category 3: Structural Components

What is MMC category 3: Pre-manufactured structural members made of framed or mass engineered timber, cold / hot rolled steel or pre-cast concrete. Members to include load bearing beams, columns, walls, core structures and slabs that are not substantially in-situ workface constructed and are not part of a systemised design. This category, although focused on superstructure elements, would also include some sub-structure elements.

Category 3 examples

Substructure: prefabricated ring beams, pile caps, driven piles and screw piles

Super-structure: columns, shear walls, beams, floor slabs.

Case study: Wolverhampton Railway Station

Design and build of a new railway station including 2 phase construction with demolition. Galliford Try were appointed by ION Property Developments, through the north-west Construction Hub Framework, to deliver the key phase of the £150m transport hub.

Methods used: to successfully deliver the project, several pre-cast elements were used including floors, lift shaft and pre-cast units.

Wolverhampton Rail Station (Insider Knowledge Profile)

MMC Category 3 Examples			
Project	**BU**	**Sector**	**MMC technique used**
Queensmead School	London & SE	Education	Structural timber walls and floor components manufactured off site
C4283 Assembly	WM & SW	Commercial	Steel reinforcement in RC structure: pre-fabricated cages.
M1 J13-J16 SMP	Highways	Highways	PC ground beam, retaining walls and floors

Category 4: 3D Printing

What is MMC category 4: 3D Printing. The remote, site based or final workface-based printing of parts of buildings through various materials based on digital design and manufacturing techniques. 3D printers now capable of printing building walls and processing cement.

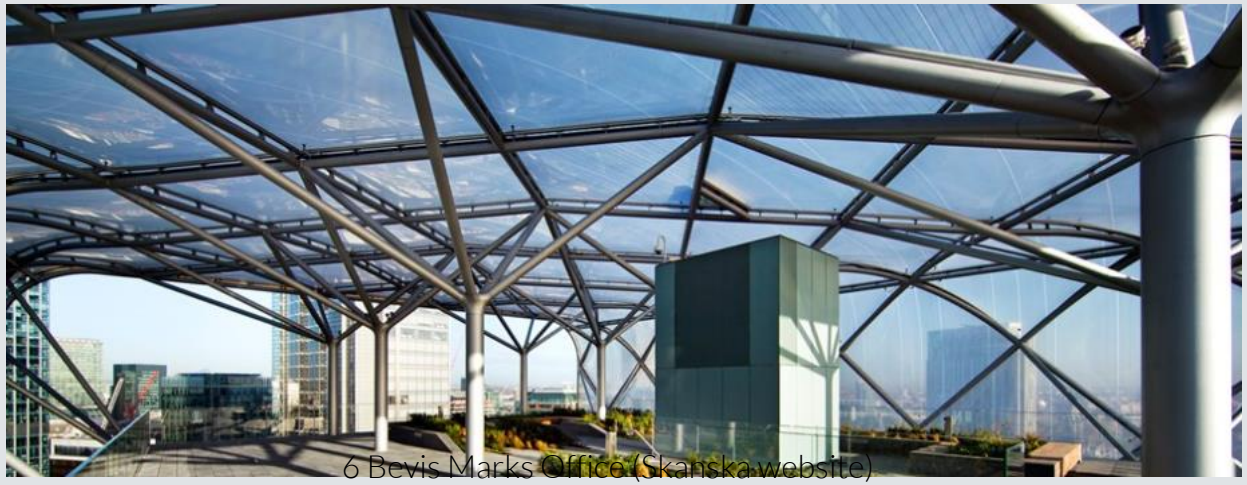
Galliford Try have yet to adopt 3D printing in to our designs. There is a high initial cost for equipment, and we have yet to identify an appropriate need for this. However, many of our competitors have embraced and implemented this technique:

Vinci: In February 2017 Vinci purchased a stake in XtreeE, a French startup company that specializes in 3D printing concrete structural elements, showing their commitment and belief in the process.

BAM: In 2019, BAM opened Europe's first concrete printing centre in the Netherlands. The factory has already been tasked to deliver several 3D printed bridges throughout the region.

Skanska: have begun research with the Manufacturing Technology Centre (part of Loughborough university. They are focusing on the delivery of the concrete via a robot (converting 3D digital drawings into robotic language).

Case Study: 6 Bevis Marks Office, Skanska



6 Bevis Marks Office (Skanska website)

As an industry first, Skanska used 3D printers to turn their digital technical drawings in to cladding shrouds on the top of the canopy (seen in picture above). Traditionally, case steel nodes would have been used to harness the interface between the roof and the supporting columns. By using 3D printed materials, Skanska saved money and time as case steel nodes are more difficult to produce.

Skanska now aim to focus on creating a 3D supply chain to further their category 4 abilities.

Category 5: Non-structural 3D and 2D

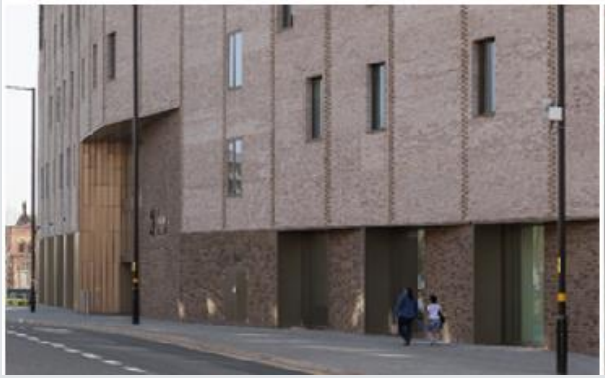
What is MMC category 5: A series of different pre-manufacturing approaches that includes:

- Unitised non-structural walling systems e.g. panelised SFS infills
- Roofing finish cassettes or assemblies (where not part of a wider structural building system)
- Non-load bearing mini-volumetric units (pods) used for the highly serviced and more repeatable areas such as kitchens and bathrooms, utility cupboard, risers, plant rooms as well as pre-formed wiring looms, mechanical engineering composites

Case Study: Birmingham City University Conservatoire

BCU Conservatoire is a highly modularised build.

Method used: had MEP service modules. The services were installed in a safer way because of the prefabricated modules. The M&E subcontractors Imtech were involved in the design process very early on to develop a fully integrated programme and review buildable strategy. This included ensuring the construction programme was adapted to accommodate the prefabricated packages. For example, the concrete roof slab sequence was modified to enable prefabricated risers to be lowered down through the building.



Birmingham City University Conservatoire (Galileo)

MMC Category 5 Examples			
Project	**BU**	**Sector**	**MMC technique used**
Symphony Hall	WM & SW	Commercial	GRC Cladding panels
Windmill Hill	WM & SW	Residential	Bathroom & shower pod
Queensferry High School	Scotland Central	Education	Composite panels

Category 6: Non-structural Prefabricated Component Solutions

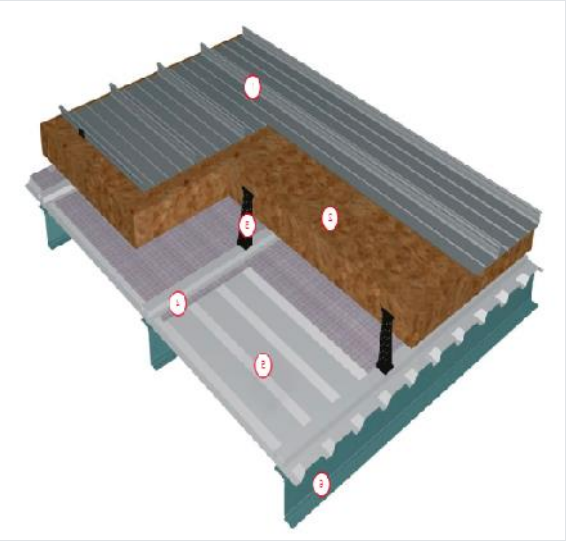
What is MMC category 6: Category 6 intends to provide site-based process improvements by reducing site labour and improving productivity on site.

This type of construction includes traditional single building products manufactured in large format, pre-cut configurations or with easy jointing features to reduce the extent of site labour required to install, examples include:

- Large format walling products – internal and external walls
- Large format roofing finishes
- Pre-sized and cut to measure traditional materials – component level systemisation
- Easy site install / jointing / interfacing features – brick slips, modular wiring, flexible pipework

Case Study: Allen Edwards School
Method used: Corium Brick Cladding

Brick slips were used on this project, as it is lightweight in comparison to traditional brick and is hung off the building, so did not require foundations and was quicker to install than traditional brickwork.



MMC Category 6 Examples			
Project	**BU**	**Sector**	**MMC technique used**
Allen Edwards	London & SE	Education	Corium brick slip
St Marylebone Bridge	London & SE	Education	Corium brick slip

Category 7: Site Process Improvements

What is MMC category 7: This category is encompasses onsite fabrication and focuses on approaches utilising innovative site-based construction techniques that harness site process improvements falling outside the 4 main pre-manufacturing categories outlined in Category 6. This category includes:

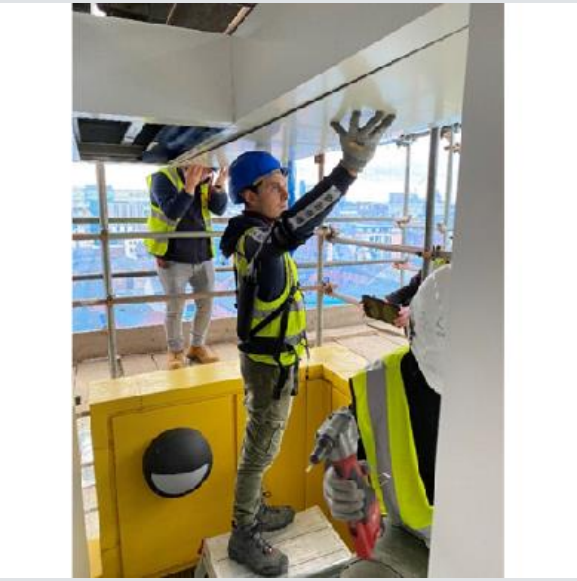
Lean construction, drones, physical and digital worker augmentation, workface robotics, exoskeletons and other wearables, verification tools and new technology led plant and machinery

Case Study: Sunflower and Catkin Centre

This project is a combination of a Children's Adolescent Mental Health Services (CAHMS) Facility and a new multi-use outpatient's facility.

Details: steel frame/composite concrete podium with undercroft accommodation and parking. Upper floors are a bespoke steel/timber frame utilising Glulam columns/beams, with Cross Laminated Timber (CLT) floors and walls.

This project has used **drones** extensively to monitor progress and update the client.



On-site photos of the exoskeleton in use

MMC Category 7 Examples			
Project	**BU**	**Sector**	**MMC technique used**
Smithfield One	North-west		EXO-01 – an exoskeleton to aid recladding and other daily activities). This was offered for use by the cladding and scaffolding contractors involved, and their feedback was logged and compiled into a study.

Premanufactured Value

What is PMV?

Pre-manufactured value is the newly coined term for measuring our level of MMC adoption. It is the percentage of a project's cost that can be attributed to pre-manufactured techniques. The more MMC we use, the higher the PMV value.

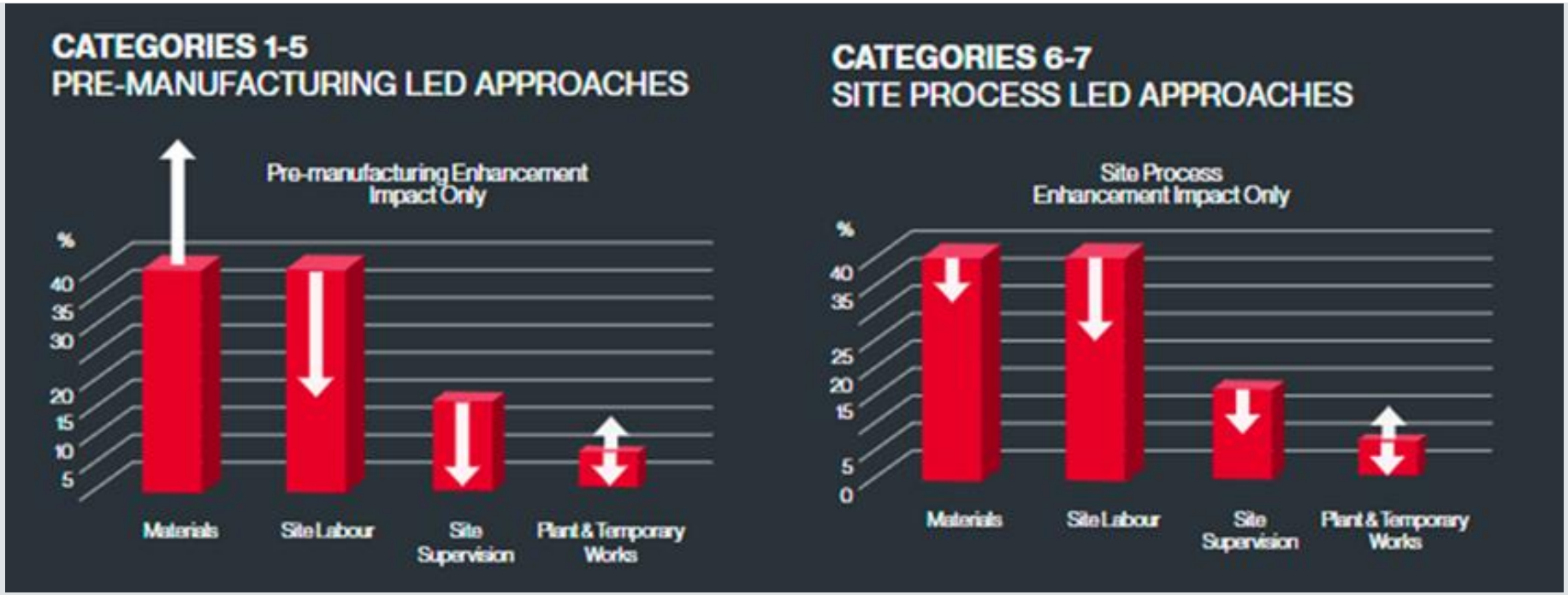
Traditional construction = low PMV

MMC construction = high PMV

The Department for Education PMV calculation

(materials + offsite labour) / (materials + offsite labour + on site labour)

Pre-manufactured value Overview



General shift of site labour to controlled manufacturing processes

Speed reduces site preliminaries including supervision

Possible upward pressure on logistics / craneage

Low wastage reduces total manufactured material content

Productivity improvements on-site reduces labour requirements

Better planning and digital augmentation reduce supervisory needs

Possible use of autonomous equipment and robotics could increase plant

Can be used in conjunction with categories 1-5 pre-manufacturing

Galliford Try's Next Steps

A database of all Galliford Try Building projects over the last XXX years that have used MMC techniques to provide a base for cross Business Unit learning. This document and the online database have been created to help improve understanding of MMC throughout the business and provide information for successful MMC applications in the future and make lessons learnt easily accessible.

The live database of MMC projects can be found here

Next steps

Our MMC Manager, Jennie Hughes is leading the next steps to increase the uptake of MMC within Galliford Try. Where MMC solutions are appropriate they can often be discounted due to common problems experienced in knowledge gaps, design coordination and on-site issues. As part of the Technical Services team Jennie is leading engagement directly with our Supply chain to seek to overcome these issues for the benefit of our project teams.

Galliford Try have been increasing their use of offsite techniques for several years. We recognise that the future of construction is paved towards increasing optimised designs for Modern Methods of Construction, and so to remain competitive.


GallifordTry