SECOND PROSPECTUS

Turning the Construction Playbook into "oven-ready" reality using...

INSURANCE BACKED ALLIANCING

BY THE DUDLEY COLLEGE INSTITUTE OF TECHNOLOGIES ALLIANCE

April 2022 Rev1

Alliance Members & Independent Assurers / Facilitators

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EXECUTIVE SUMMARY

"*We need to change our approach to delivery",* declares Government when endorsing the Construction Playbook. Although one wouldn't disagree with any of its content, despite its title the Playbook won't be game changing any time soon.

Again, Frameworks that keep successful teams together are clearly valuable. "Constructing the Gold Standard" for frameworks is however a lawyer's review that will do little to deliver radical change on actual projects.

When projects are collaborative and their teams integrated, they deliver success. Usually these come about when the client is discerning and strong, overriding the edicts of traditional procurement. In a break with tradition in 2011 Government endorsed "new models of procurement" for trial. The "IPI model", the first in the generation of "Insurance Backed Alliancing", has now been successfully trialled.

In this second Prospectus the **Dudley College Institute of Transformational Technologies alliance** reveals how it delivered outcomes that exceeded expectations in terms of programme, cost and running costs; and how the now vogue imperatives of "Environmental, Social and Governance" were an integral part of that success.

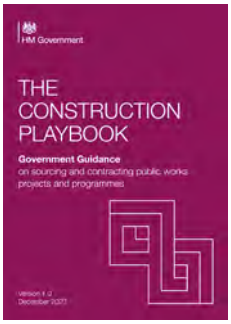
So our message to Government and the industry at large is: stop investing in lengthy reports which construction practitioners won't read. Insurance Backed Alliancing is "oven-ready": it does change our approach to delivery". Don't waste more years trying to invent something else.

Instead: define the project brief, select the best team of organisations and people to deliver on that brief, empower them in an "insurance backed alliance" which assures collaboration, risk management and "no blame" – and you will get the results you deserve. If you want to know more, please read on.

INTRODUCTION

The approach to delivery must be changed

In the Foreword to the Construction Playbook the Chief Operating Officer for the Civil Service and Permanent Secretary for the Cabinet Office laid down this challenge:



Delivering excellent public works is critical for the government to deliver the public services that we all rely on. Up to £37 billion of contracts across economic and social infrastructure will be brought to market over the next year, ***and to meet this ambition we need to change our approach to delivery.***

Although the construction industry has improved in certain sectors, the extent of its failures in other sectors is evidenced by Grenfell Tower and the emerging revelations from the Enquiry. McKinsey[1] have found:

Construction is responsible for a wide range of impressive accomplishments, from stunning cityscapes and foundational infrastructure on a massive scale to sustained innovation. However, in the past couple of decades, it also has been plagued by dismal performance…

Risk aversion and fragmentation as well as difficulties in attracting digital talent slow down innovation. Digitalization is lower than in nearly any

1. The-next-normal-in-construction.pdf (mckinsey.com) June 2020

other industry. Profitability is low, at around 5 percent EBIT margin, despite high risks and many insolvencies. Customer satisfaction is hampered by regular time and budget overruns and lengthy claims procedures.

A 2016 McKinsey analysis found that construction projects typically take 20 percent longer to finish than scheduled and are up to 80 percent over budget, frequently resulting in litigation. That often leaves customers dissatisfied, resulting in complex and time-consuming claims processes.

The Playbook was published in December 2020. In October 2021 the Minister of State for Higher and Further Education officially opened the Black Country & Marches Institute of Transformational Technologies ("IoTT") at Dudley College of Further Education – which has already delivered the above ambition.

In the words of the College's Executive Director of Estates and Capital Projects:

"The College's bid for the Institute of Technology programme was based on the Integrated Project Insurance ("IPI") model of procurement and delivery in order to ensure the best value for money and predictability of outcome that was secured on Advance II, the College's first IPI project.

The outcomes on our IoT facility for advanced manufacturing, modern construction methodologies and medical engineering have been truly exceptional: the alliance's collaborative culture alongside use of a truly federated BIM model minimised set-backs from both Covid-19, as well as the more usual design issues experienced on a traditional project, especially on site.

Final design and build cost was about £58/m2 below the DfE's standard schools benchmark and about £130/ m2 below the bespoke benchmark derived for this complex facility; and running costs are already projected to be 62% below the Advance I building that was procured on traditional "design & build" to BREEAM Excellent standards.

IPI has transformed the College's experience with the construction industry, and we commend it to DfE and other departments that spend public money."

At the start of this post-Brexit era when Government is embarked on "Transforming Public Procurement" and Frameworks are under scrutiny, we, the members of the Dudley IoTT Alliance, have some messages for the Government and Industry which will make the Playbook "game-changing".

We will describe, with the evidence of the IoTT project, how to turn the Playbook's aspirations into "oven-ready" reality; and we will indicate a strategy for yet further improvement.

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Procurement: the heart of the problem

Under Effective Contracting, the Playbook starts right:

Deciding on the correct commercial approach is critical to achieving the intended benefits and wider value. The commercial approach should be linked to the delivery model, the desired outcomes and type of relationship you want to have with the supply chain. Depending on the commercial approach and nature of the works, this will impact the procurement procedure and contracting strategy.

One of the most effective ways to deliver outcomes is to create contracting environments that promote collaboration and reduce waste. Contracts should create positive relationships and processes designed to integrate and align multiple parties' commercial objectives and incentives.

It goes on briefly to broach alliancing, albeit in a tentative tone:

Experience shows that while alliancing arrangements are not always appropriate, they should be considered on more complex programmes of work as the effective alignment of commercial objectives is likely to improve intended outcomes as well as drive greater value for money. Alliancing models also provide more effective integration, which leads to effective and aligned arrangements, and enables engagement with the wider supply chain and platform delivery.

Because of their widespread adoption in the public sector, Frameworks get fuller mention:

Frameworks are an efficient method for government to procure public works, goods and services and can provide an opportunity for contracting authorities to access economies of scale. However, using frameworks inappropriately can have negative consequences for contracting authorities, markets and suppliers, and can unintentionally inflate prices.

A successful framework contract should be based around principles that align objectives, success measures, targets and incentives so as to enable joint work on improving value and reducing risk. This should then be combined with transparent performance measurement and work allocation procedures.

There followed a reference to the review which was commissioned from the Centre of Construction Law, King's College, London:

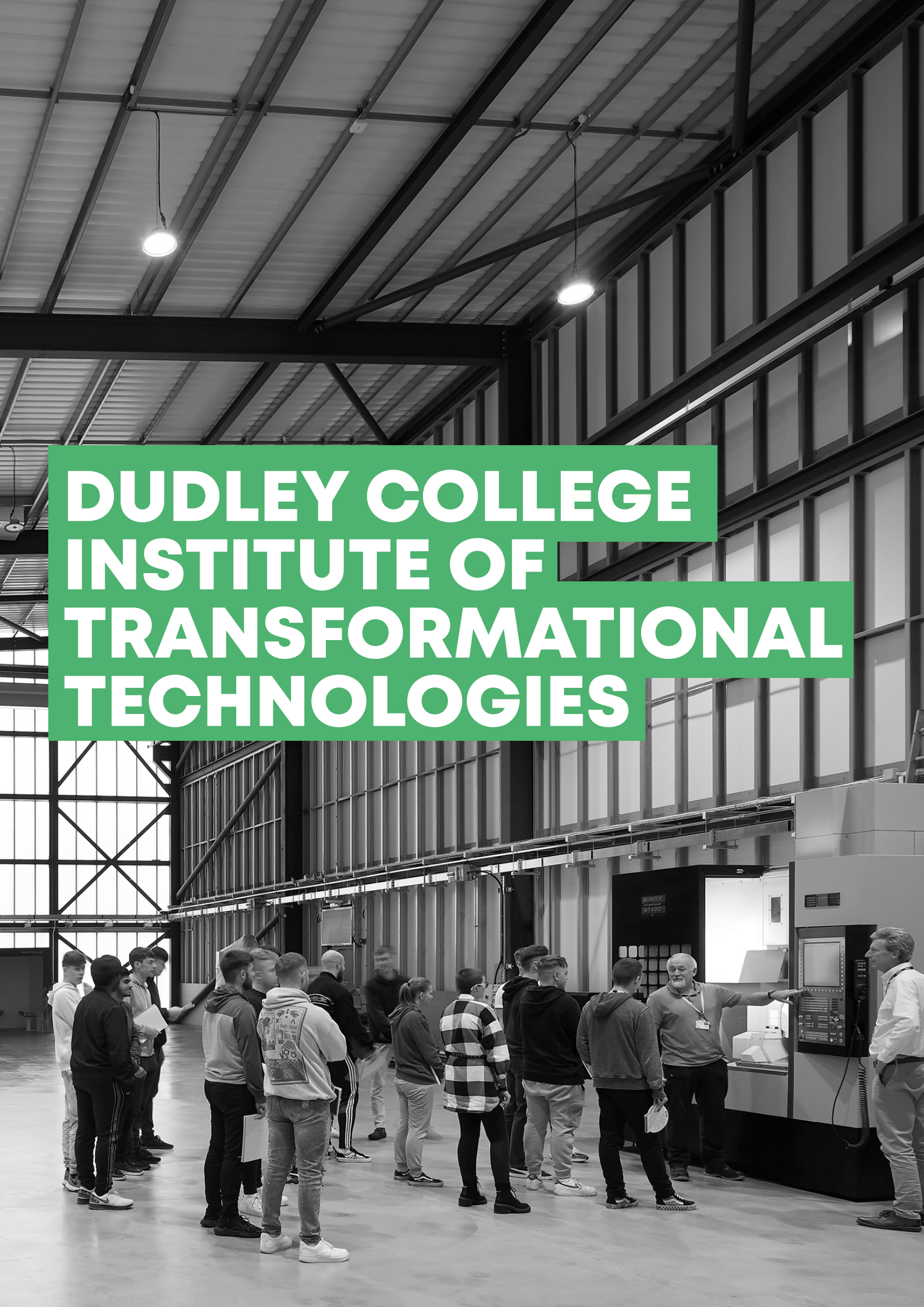
We will complete a review of the current landscape of frameworks with a view to consolidate, where appropriate, and adopt a new 'gold standard' for frameworks. This will enable contracting authorities to easily identify those frameworks which meet best practices and embody the principles and policies set out in this Playbook. There will be a number of framework options to ensure competition and flexibility across government.

This review, "Constructing the Gold Standard" singles out the FAC-1 "Framework Alliance Contract", also written by the Centre of Construction Law, King's College, London and published by the ACA, but it is important to be aware that, as stated in its briefing paper, *"FAC-1 is not itself a Project Contract form and is designed for use with any one or more Project Contract forms"*, going on to list

- *any of FIDIC/ICC/JCT/NEC/PPC contract forms, subcontracts and term contracts*
- *any of ACA/ACE/CIC/FIDIC/JCT/NEC/RIBA/ RICS consultant appointments.*

Furthermore, such proliferation of traditional or quasi-traditional forms is potentially magnified in the Review by the proposition of a supporting *"ecosystem"* of five different types of framework contracts under which *framework providers, clients, managers, suppliers and supply chain members* could operate.

Framework alliancing is clearly the way forward, but it requires collaboration not a complex legal nexus as an enabler. Such a panoply of documentation would be lost on the industry's practitioners and could result in dysfunctionality and litigation.



DUDLEY COLLEGE INSTITUTE OF TRANSFORMATIONAL TECHNOLOGIES

Procurement of the alliance for Dudley IoTT

Before describing how the IoTT alliance delivered the project, it is necessary briefly to explain how its procurement circumvented the well-known flaws of traditional procurement:

- Inviting bids and taking the lowest price
- Perpetuation of the fragmentation of the industry (consultants/contractors)
- Undue reliance on the covenant of main contractors
- Lack of engagement with the supply chain

When bidding to DfE for the funding for the IoTT project, the College stipulated that it should be carried out under the Integrated Project Insurance model which was endorsed for trial under the Government Construction Strategy 2011. Under the branding of "Insurance Backed Alliancing", this model is described in detail in a Prospectus[2] but the key elements of the process up to award were briefly:

- The need was defined as "to deliver industry focused programmes for the transformational sectors of advanced manufacturing, modern construction methodologies and medical engineering" and expressed in a strategic brief [3]
- Instead of appointing design consultants to do design, inviting contractors to tender against that design, and then instructing the contractors to build to that design, the College appointed an "alliance" of suitable consultants, contractors and specialists as their partners at the outset jointly to develop the best solution to meet the strategic brief within a benchmarked "investment target[4]" in accordance with UK Public Contracts Regulations 2015[5]
- The selection of the organisations and the specific project staff was based on their capability and track record to deliver the specific IoTT project cost - effectively to time and quality - not just as individuals but as partners in an alliance. The process included written ITT submissions, interviews and team behavioural workshops.
- During the selection process an independent facilitator and independent technical/financial risk assurers advised on suitability and could warn if any party would be uninsurable.
- The selection and award procedures were conducted between March and June 2018 and complied with EU Directives and the corresponding UK Public Contract Regulations.
- The alliance contract incorporating "no blame/no claim" undertakings was duly signed on 2 August 2018. The structure of members, suppliers and other parties is shown in Appendix 1.

Alliancing in practice

Under "commercial alignment" customary processes and behaviours are immediately transformed. The traditional constraints that inhibit innovation, generate protectionism, incur process waste and undermine enjoyment are removed. Instead, the model treats commercial alignment of the interests of the client and all the partners as a first priority, with focus over the first 60 days on activities such as:

- Agreement of the "alliance principles" that will govern members' conduct
- Selection of the "best for project" individuals from those offered in the bids to represent the alliance
- Appointment of the alliance manager and alliance cost manager
- Reaching a common understanding of the operating principles of the "commercial model"
- Audit of each partner's overheads and profit for inclusion in the "ring-fenced sum"; and agreement of parameters for incentives
- Agreement of a Trust Deed and operating arrangements for payments.

Commercial alignment was deemed complete in 56 days. This achievement reflected the collective enthusiasm of the partners for the award to become unconditional, enabling immediate commencement of Phase 1, and it was achieved despite the fact that several alliance partners who had not worked via an IPI form of contract were going through the IPI learning curve and gaining understanding of the commercial model. There is provision for the 60 day period to be extended to ensure the activities can be thoroughly completed but this option was not taken up.

Phase 1

The first task was for the Integrated Project Team (IPT) to be formed and to prepare the Project Execution Plan ("PEP") for Phase 1 for approval by the alliance board. The following elements of the

2. 201803-Prospectus-rev-1-Mar-2018-002.pdf (constructingexcellence.org.uk)
3. The strategic brief set out business needs/functions and prioritized success criteria; not solutions.
4. The investment target was based on DfE benchmarks for schools and will be discussed later.
5. Article 67(1) - (4)

PEP were singled out as of pivotal importance for future success, and the issues encountered, and the methods of resolution adopted, are discussed below:

- Selection of the members of the IPT who would be best placed to collaborate to meet the brief and success criteria cost-effectively
- Identification of the tasks required for Phase 1, including identification of the sequence in which the tasks need to occur along with their reliance on other tasks, with time allocations applied so that budgets could be agreed and ratified.
- Development of a BIM Execution Plan ("BEP") and information management system
- Deciding when to engage key suppliers and on what terms
- Development of a programme showing time and resources required
- Development of cost management procedures and cash flow forecasts
- Priority to be given to team-building events in conjunction with the independent facilitator.

Later in Phase 1 these decisions needed to be projected for the Phase 2 PEP.

The prerequisite to successful optioneering of "best for project" solutions was establishing "true and sustainable integrated collaborative working amongst the members of the IPT".

Comprising architectural, structural and engineering system designers, the constructor and M&E specialist contractors, the IPT was in a position to bring together conceptual thinking and practical application so as to find the best project solution within the total budget.

Amongst 15 "success criteria" (not here listed in order of priority) were:

- *Build quality to give an exemplar to learners and staff, with a high quality learning environment that inspires. The finished building should be a bright clean high-tech environment mirroring the industry norms for the supported sectors*
- *'Function over form' to ensure the best possible facility for training within the investment target and the maximum possible delivery space is achieved within the envelope*
- *It is preferred that the buildings will be predominantly naturally ventilated*
- *Design aesthetics of the building must make a statement of its quality and that of the Institution it represents*
- *Leading BIM level 2 or better methods and technologies are adopted from commencement including soft landings considerations from BSRIA from the start*
- *Durability of the building making it robust, easy to maintain and clean, with life-cycle cost considered in all capital investment decisions*
- *Flexibility of the facility to be remodelled to meet future changes in demands and training methods, rather than adaptability for short term change*
- *Whilst the IoTT is not required to achieve BREEAM excellent, there is an aspiration that the best from BREEAM combined with a highly efficient external envelope, in terms of air tightness and thermal efficiency, will result in a building of very low running costs*
- *The IoTT is required to achieve an EPC A rating.*

All these criteria naturally invited an architectural lead – which was facilitated by the flexible structure of the IPT, supported by the alliance board. We now give the floor to our architect partner, Cullinan Studio, led by Peter Inglis.

“Successful optioneering of “best for project” solutions was establishing “true and sustainable integrated collaborative working amongst the members of the IPT”

The Architect's Perspective

The traditional design approach at concept stage

Cullinan Studio's design approach is always collaborative, but in a 'business as usual' commission it would be very unusual to have all the other parties, necessary to complete a building project, available at the outset to collaborate with. Certainly, it is vanishingly rare to have the chosen contractor fully engaged before a single design concept is drawn.

The design risk in the traditional approach is that the architect is often leading the design with only partial construction information, and the inability to fully test ideas with those that will build the project, and sometimes at concept stage even without full engineering support. Although experienced architects will be able to negotiate this issue fairly successfully, using knowledge from prior projects, inevitably some elements of design will get baked-in at concept stage that may add hidden cost to make work.

And it is certain that innovative design ideas are far harder to verify without an integrated team, meaning new ideas may be priced cautiously by a QS with an unnecessarily high degree of design risk, making them easier to reject for tried-and-tested solutions (ie business as usual) before they have a chance to develop.

The difference with IPI on the IoTT

It is important to state that having a fully integrated team, assembled prior to design work taking place, is not an "anti-design" proposition. The first four of the above success criteria are design-led aspirations. Some are 'hard' factual design criteria, and others are 'soft' visual design criteria. But, in order to satisfy both, there needs to be a design lead within the process to turn the vision into option proposals, for the integrated team, as a whole, to respond to, test and help develop.

Cullinan Studio discovered early in the process, when engaging the supply chain, that constructors work best when there is some sort of proposal, however loose and basic, to work with. A conversation around a blank sheet of paper did not go very far. So the key for the architect in the process was to be producing and developing

ideas just ahead of the rest of the team, but being completely open in the process so the team could contribute, test, propose alternative solutions in a structured way before any element got set. So thinking and modelling ahead, but only just ahead, and with an openness to that work sparking better ideas.

Also on the value of design: one of the key aspects of the formation of the IPT is the agreement during commercial alignment of the contributions in time of each team member, and within each team member the skills and attributes each person will contribute to the task in hand. This is where the true value of each member becomes clear, and it was clear in the process that design input was vital and valued by the alliance. Design hours were understood to be time invested in achieving the best for project solutions.

Skimping on design time would mean more risk that (a) innovations could not be developed to the point they yield lean, efficient solutions; and (b) details were not resolved to a degree that would open up potential coordination issues on site. Compare this to a business-as-usual world of lowest price fees resulting in on-site issues and wasteful last-minute cost-cutting.

Contribution from the Constructor:

During early Phase 1 design workshops, the alliance team (as one team together) was able to consider a number of design ideas, specifically around the roof structure/shape with input from the constructor steering the team away from certain designs that would have resulted in extensive temporary works costs, such as scaffolding and crane work, with these costs not contributing to the end result i.e. simplifying the construction method to release costs for the permanent works.

Cases in point:

Form and positioning of the building.

The building design varies significantly from a previous proposal by another architect for the site. That proposal had similar design success criteria, but achieved them by siting the buildings for visual impact, and then working out the engineering to make that work. The noise from the adjacent busy road had a profound impact on these follow-on design choices.

When the IPT assessed the solution, we identified various expensive solutions around windows and acoustic attenuation, necessary because of the initial choices. This is not to denigrate the previous design, but to show this is a typical logical conclusion of the architect working in isolation, with technical solutions following too far behind.

With a full IPT assembled, the architect could look at several iterations of the form, working with the M&E engineer, acoustic engineer and contractor to find a form factor that found the best way to:

- Be efficient in enclosing maximum space in the envelope.
- Maximise naturally ventilated rooms without resorting to acoustic attenuation
- Bring in good daylight, while minimising unwanted solar gain.

The contractor could take basic areas from the model; the acoustician could test different scenarios quickly, all before any detailed work was carried out. This joined-up approach resulted in a T-shaped form with the head of the T providing an acoustic buffer to the naturally ventilated classrooms situated facing away from the road.

Having the contractor as part of this very initial exercise meant they could propose moving the building on the site a small amount (approx. 5m) to the south. This change was entirely insignificant to the success criteria of the building design, but made a big difference to the logistics of the residual loading area, which would eventually reduce prelims and programme risks. This is an elimination of waste at a point where there was zero addition to the design time or the client's built asset. But it would not have happened this way under a traditional approach.

In all likelihood, the 'normal' course of events would be a tendering contractor spotting this opportunity, but only after a detailed design and full planning permission was secured, meaning the returns of making a change would be offset by the cost, time and risk of redraws and re-submissions.

Selection of frame and heating solution

The choices of how to construct this building produce many interacting consequences. Each could be assessed independently, but the best solution for each component may not produce an overall mutually compatible system.

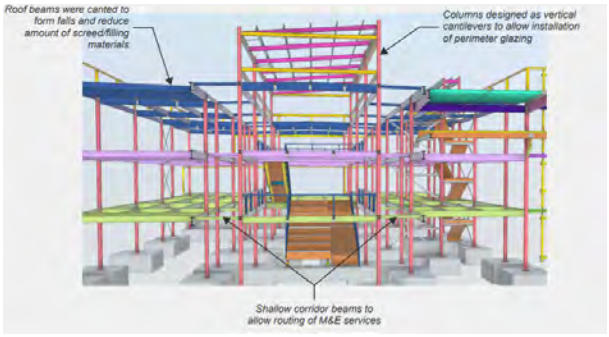
Looking at the frame and heating solutions together, with the input of the whole team, allowed

Contribution from the structural/civil engineer:

In addition to the usual permanent and variable loads the structure needed to resist significant earth pressures introduced by a propped retaining wall to the Western elevation, the large central atrium added a degree of complexity in the overall behaviour of the structure as it created a discontinuity in the diaphragm action. This was resolved by the introduction of additional braced bays concealed within internal walls. These were positioned to avoid plan torsional effects whilst meeting the architectural requirements.

cost, buildability, weight, programme, efficiency and future flexibility to be assessed together. The chosen solution of a steel frame and TABS system was assessed to be best for project, and as it happens this was the solution that had also been used on the previous IPI project at the college.

The final design however was a further iteration in lean thinking from the solution used previously. The permanent formwork was a different profile, which allowed for a reduction in concrete volume and hence cost. There was some added complication to partition heads underneath, but this was not significant. In fact, it meant that there was more confidence in the firestopping as the gaps were filled in a cleaner manner, with less risk of unseen pathways



Cladding Solutions

The design of the cladding system was led by the success criteria around making a quality statement, and mirroring the skills and aspirations of the Institution. The client was clear that the building should project a ‘high tech’ feel. The design team looked to a solution that used local fabrications, of a type that might be familiar to apprentices within the college. The cladding is mill-finished aluminum, with simple folds and perforations of a type that could be achieved within the machinery in the college.

The IPI process allowed the design team to work with the selected sub-contractor to set-out the cladding to minimize waste in production for the leanest cost. Working with suppliers in the design process is not at all unusual, but it is often the case that on finalizing a design, the contract is put out to tender and a different supplier is awarded the job, perhaps with the subsequent need to alter the design. Here the supplier could work with the team to find the least wasteful design, using rates in an open book manner, in the knowledge that the job was more certain.

The IPI arrangement allowed the architect to model the solution, using the supplier’s cost rates within the BIM model to fit the areas of cladding to meet the cost plan budget for that element. As the model was open and the pricing transparent, there was a very good ability to work collaboratively on this, with an assurance that the solution was being designed absolutely to cost, and the contractors cost was based on actual modelled elements. This was a unique process in the experience of the architect, enabled both by BIM and by the contractual arrangements of IPI.

Cost Planning, Opportunities and Risks.

From a design perspective, the IPI approach to cost planning, using target costs and a priced opportunity and risk schedule, allowed design work to progress with a much clearer idea of the budget, and where efficiencies could best be pursued.

The cost plan was in effect a central live design tool at both IPT meetings and board meetings, rather than an opaque reporting mechanism leading inevitably to last-minute VE. This changed completely the approach to design, being able to agree what was worth pursuing and what

wasn't as a team. It made the job of the individual designers clearer, and led to fewer frustrations about decisions, since the process of agreeing the way forward was always transparent and with a stated purpose of meeting the cost and/or the programme.

Of course, we'd all rather have a bit more budget, but having oversight and a degree of control over where the budget was being spent, brought the best out of the designers, utilizing their abilities to problem-solve and innovate cost-effective solutions.

This enhances the value the project gets from its design team , where there is a vast reduction in mis-placed effort, and skills are employed positively and directly for the benefit of the project.

The reduction in frustration with the process was part of the improvements in mental health reported in feedback sessions following handover of the building.

Context of the drive towards Net-Zero

At the commencement of Phase 1, when the success criteria were being established, there was a clear sense that established industry environmental benchmarks were not necessarily appropriate to the client's needs or indeed where the team believed best practice could and should be.

The BREEAM criteria are a case-in-point. BREEAM, by its nature is a very broad credit-gathering based certification system.

It can be bureaucratic and resource heavy – the antithesis of the lean approach encouraged by IPI.

Fundamentally, the client's ambition towards a low-carbon low-energy solution would far exceed the energy requirements of BREEAM 'very good' and potentially BREEAM 'excellent'.

However, many of the other non-energy credits that would be required to meet these BREEAM standards would be challenging or expensive on this site, while being of little perceived value to the client.

BREEAM was not a criterion set down by either the planning authority or the DFE funders.

The risk of following a BREEAM path would be that the finite project resources would potentially be re-directed by compliance-driven necessity at areas of less value to the client, to the detriment of a best-practice energy solution.

For want of a better title, the agreed success criteria were labelled as Best of BREEAM, as shorthand for meeting or exceeding the low energy targets, water use, ecology etc. of BREAAM excellent, without the requirement for full overall compliance or certification.

Industry Benchmarks published during the project

Since the commencement of the project, there has been a concerted effort by the design and construction industry to set-out a meaningful best-practice roadmap towards net-carbon-zero.
Two key initiatives are:

1. RIBA Climate Challenge 2030 – Initiated 2020
2. LETI Climate Emergency Design Guide – Published 2020

These were not available at commencement

of design or briefing. Nevertheless, as they are becoming more commonly accepted, they have formed useful tools in how the IOT team's design, in responding to the agreed performance criteria, actually sits in relation to industry best practice targets for both operational and embodied carbon.

The short answer is very well in some regards:

For operational carbon, the energy use of 76 kWh/m2/y is only 58% of a standard 'building regs compliant' building, and close to the RIBA's climate challenge 2025 target figure of 70 to 75 for a non domestic building – so broadly where we need to be according to that best-practice road-map - *(see table on page 21)*.

The embodied carbon figure is even further ahead, meeting best practice non-domestic targets for 2030 of 540-750. In this case, a strong argument could be made for the lean-thinking approach adopted as part of the IPI process being well aligned with some of the key principles of driving down embodied carbon – principally in using less material overall, and reducing waste.

This is very encouraging, especially as the building has been delivered under the agreed benchmark DFE figures. i.e. it's below business as usual cost, for best practice performance.

“Certainly, it is vanishingly rare to have the chosen contractor fully engaged before a single design concept is drawn

RIBA 2030 Climate Challenge target metrics for non-domestic buildings:

RIBA Sustainable Outcome Metrics	Business as usual (new build, compliance approach)	Black Country & Marches IoT **2021**	2025 Targets	2030 Targets
Operational Energy kWh/m²/y	130 kWh/m²/y	**76 kWh/m²/y**	New-build schools: < 70 kWh/m²/y Offices: < 75 kWh/m²/y	New-build schools: < 60 kWh/m²/y Offices: < 55 kWh/m²/y
Embodied Carbon $kgCO_2e/m^2$	1000 $kgCO_2e/m^2$	**738 $kgCO_2e/m^2$**	New-build schools: < 675 $kgCO_2e/m^2$ Offices: < 970 $kgCO_2e/m^2$	New-build schools: < 540 $kgCO_2e/m^2$ Offices: < 750 $kgCO_2e/m^2$
Potable Water Use m^3/pupil/year	4.5 m^3/pupil/y	**1.6 m^3/pupil/y**	< 1.5 m^3/pupil/y	< 0.5 m^3/pupil/y

Operational Carbon

The driving principle in reducing energy use, while maintaining budget was achieved by adopting a 'fabric-first' approach.

Principal design decisions were made in relation to the building fabric in such a way that energy demand would be reduced from the outset, rather than looking for technological/mechanical fixes to address problems of the design's own making.

This involves a high degree of robust decision-making discipline, involving all the skills of the design and construction team considering the issue in the round from the outset. IPI, by its nature, is ideally suited to the holistic approach inherent in successful low-energy design.

The team considered building massing, shading, solar heating, and the effect of noise from the adjacent A-road. Also taken into account were long-term maintenance, capital cost, ease of construction, and future flexibility.

Several options were modelled across disciplines, tested and costed. The best overall form was a three-storey T-shaped block, which used the 'head' of the T as an acoustic buffer to the road. The head element contains the 'noisy' spaces such as the hanger, and elements that require assisted ventilation – WCs and some IT-heavy spaces. This approach allowed all the teaching spaces to be passively ventilated, using normal opening windows, and passive acoustic vents to the atrium. The windows are sized and shaded to minimize unwanted heat loss and unwanted excess solar gain.

The heating system is a low-temperature hot water system embedded into the floor slab (Thermally Active Building Slab - TABS).

Embodied carbon:

The team have used the H/Bert embodied carbon measuring tool to calculate embodied carbon:

It should be stated that there was not a target embodied carbon figure set at the commencement

Contribution from the structural/civil engineer:

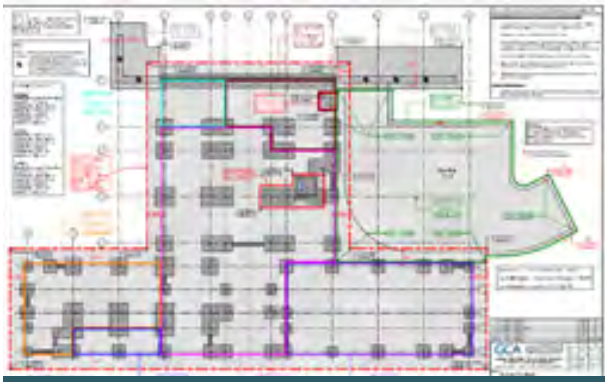
The IoTT building is located in a brownfield site previously used as a goods station for the railway. Key challenges overcome included limestone mining, relic structures, a 6m deep culvert, a significant depth of made ground, uneven topography and poor bearing capacities. All were overcome through innovative and collaborative working which ensured key design decisions were made on a 'best for project' basis with the input of all parties.

of the project. Neither was there an active carbon reduction drive during the design process. Nevertheless the figure produced is in line with the published roadmaps to net-zero cited above.

The largest single carbon-heavy components in most projects are the substructure and frame/slab elements, principally because of the use of concrete and steel within these components.

Foundations:

The IPI methodology for driving cost and waste out of the groundworks involved spending additional design resource and ground investigations to examine leaner alternatives to a 'standard' concrete piling solution. The opportunity and risk approach – looking at the potential opportunities (savings) vs the risk (that the paid design work would show piling was still required)



Ground improvement strategy

– was agreed by the alliance board to be worthwhile pursuing: effectively taking a calculated risk in investing for a worthwhile return.

The outcome: stabilised ground as part of the remediation works, entirely eliminated the need for piling, instead allowing a raft foundation, significantly reducing the volume of concrete required. The cost of the additional design work was minimal in relation to the overall savings achieved in materials and in time. The consequential savings in embodied carbon follow directly from the reduced volumes in concrete.

Contribution from the Constructor:

Another advantage of carrying out the soil stabilisation is the fact that keeping all excavated materials on site, preventing haulage of material off site, reduced the amount of imported stone required. (Reduced carbon footprint, road safety, reduced congestion & impact on neighbours) The stabilised ground created an improved working platform on site, aiding with on-site vehicle movements throughout the construction process. The final advantage of the soil stabilisation is that it reduced the construction programme, vs piling works by about 3 weeks

Frame and Slab.

Similarly, working through the lean-design principles together with the subcontractors and suppliers, to optimize the frame design to minimise steel weights, almost automatically produces a solution that reduces the embodied carbon within that element.

The slab solution, using permanent steel formwork, uses appreciably less concrete than a flat slab or precast slab solution. The particular formwork chosen – a trapezoidal form – requires less volume of concrete above than the re-entrant version used on Advance II.

This is an example of taking a successful solution and examining it further for additional incremental improvement in terms of material use and redundancy.

There is a virtuous cycle at work here, since the reduced weights of steel frame and slab feed back into the foundation design, allowing additional savings to be made there.There are virtuous cycles also within the M&E strategy.

The lean-thinking, fabric-first approach on the M&E design which allowed a bias towards simple passive systems, consequently reduced the amount of mechanical plant with its associated ductwork and pipework, filters, cabling etc. As well as removing cost in construction and in use, this approach also eliminates the associated embodied carbon.

When considering M&E, it's important to understand that the lifecycle of air handling components is appreciably shorter than that of the building overall, with some elements requiring replacement annually. So in looking at a whole-life embodied carbon picture, every element of M&E removed, can represent a substantial carbon saving.

Next steps towards zero embodied carbon

Timber frame solutions - which would potentially have given a lower embodied carbon than steel - were examined, but were not viable in this case due to an early steer away from timber from the project insurers.

Working with insurers to foster an understanding of the role of timber in further reducing embodied carbon, and how the perceived risk of this material might be mitigated through design, will be something to take forward on future projects under IPI.

Tackling the issues of inappropriate benchmarks

The Government Construction Strategy 2011 stressed, in its Executive Summary:

"value for money and competitive tension are maintained by effective price benchmarking and cost targeting, by knowing what projects should cost, rather than through lump sum tenders based on inadequate documentation…"

In the same vein, the Playbook states that "a firm understanding of cost and performance is critical to good decision-making and successful project and programme delivery. Inaccurate estimates may lead to unrealistic expectations, which can derail a project's chances of success".

In order to inform its approval process DfE used their Cost Model One (for 3Q2020) which is set at a "mid-range quality" for general teaching and vocational curriculum and was thought to be the best available for the IoT programme.

It was obvious that this did not match the functional brief, which required a high-quality design with laboratories, specialist facilities and detailing that minimise whole life costing for the future.

Negotiations with DfE reached a point on 6 November 2019 where there was a gap of 8.77% remaining to be bridged (based on 4,750m²) as below:

	Project Cost (excl. F&E)	Rate £/m²
College	£16.870m	£3,551.58
DfE	£15.510m	£3,265.32

The outcome of these negotiations was that DfE approved funding of £16.470m. Pending further discussion with DfE, the College proceeded with the project.

The alliance however decided to omit the construction of the Prototype Hub whilst maintaining the wherewithal to reintroduce it when the funding shortfall was resolved.

Discussion then concentrated on a list of exceptional items totalling £1.5m, £920k of which the College maintained had not been included in the funding calculation.

On 8 June 2020 DfE approved a further capital grant of £889k, bringing the total DfE funding to £17.359m and allowing the re-introduction of the Prototype Hub.

A valid benchmark that recognized the complexity of the facility had however to be found, even if that was to be retrospective; otherwise, the performance of the IPI model, which was a requirement of the College's Application, could not be assessed.
The availability of a realistic ("Should Cost") benchmark is of special importance as it enables the

RICS Cost Prediction Professional Statement, Global, 1st Edition

alliance to manage cost "top down" through the IPI project process.

The International Construction Measurement Standards (ICMS) as endorsed by the RICS in "Cost Prediction Professional Statement, Global, 1st Edition" (effective from 1 July 2021) should complement this process.

Rider Levett Bucknall, the Financial Independent Risk Assurer under the IPI process, was therefore asked to devise an appropriate benchmark for Dudley IoTT using independent objective data and other synthetics that ought to be recognised by external reviewers including DfE. After discussion it was agreed that RLB would:

a). use BCIS cost data: their initial assessment was that IoTT lay somewhere between, "specialised teaching blocks" (£2,083/m²) and "mixed facilities" (£2,504/m²), both at 23 December 2019; as this range would account for almost £2m, it was decided to do the analysis at a granular level, relating the applicable BCIS data to the individual functional areas agreed with the College, and where there was none, interpolating a professional evaluation.

b). for those cost elements that are not included in the BCIS cost data, such as professional fees and contingencies, adopt percentages used by DfE in their calculation.

c). for exceptional items, use the costs approved by DfE in addition to the "external works" they had already included.

RLB's "granular" analysis, based on 4,750m² (including the Prototype Hub) came to £2,273.54/m², at 2Q2020 and at West Midlands Region indices, bearing out RLB's prediction (in (a) above). How this built up to a total benchmark cost of £17.703m (excluding land and furniture, fixtures & equipment) is shown below:

Item	Basis of calculation	£/m² (rounded to 2 d.p.)	£
Elemental cost	BCIS data applied by RLB	2,273.54	10,799,315
External works	DfE table 6/11/2019	168.54	800,578
Exceptional items	DfE email 8/6/2020	187.17	889,088
Prelims, OH&P	Included in BCIS data	-	-
Contingencies	At 5% on above as DfE	131.46	624,449
		2,760.71	13,113,430
FF&E	Not included		
Professional fees	At 12.5% on above as DfE	345.09	1,639,179
VAT on above	At 20%	621.16	2,950,522
	Total project cost	3,726.97	17,703,131

Playtime before action

Bonding for action

The impact of two suspensions

The first suspension to impact the project was from 28 January to 18 April 2019. The College had funded the optioneering and design work for the first 3 months of Phase 1 but then suspended design work until the delayed DfE funding emerged.

After the initial enthusiasm of winning this prestigious project the alliance team was deflated, some members moved onto other projects, and it was important that the team were drawn back together and reinvigorated in a similar fashion to the procurement i.e. a team-build and behavioural workshop.

The delight was clearly seen as new and 'old' alliance members re-engaged and were remotivated to commence activity on the project again.

The IPT then had almost a year of unimpeded activity, progressing the design on BIM and, on 24 February 2020, starting site enabling works.

In March 2020 the Government started to impose restrictions because of the growing impact of Covid-19, and to implement the Government's social distancing recommendation the Construction Leadership Council published Site Operating Procedures, with the strong recommendation that these procedures be implemented by every operational construction site. The alliance board considered the options and decided that

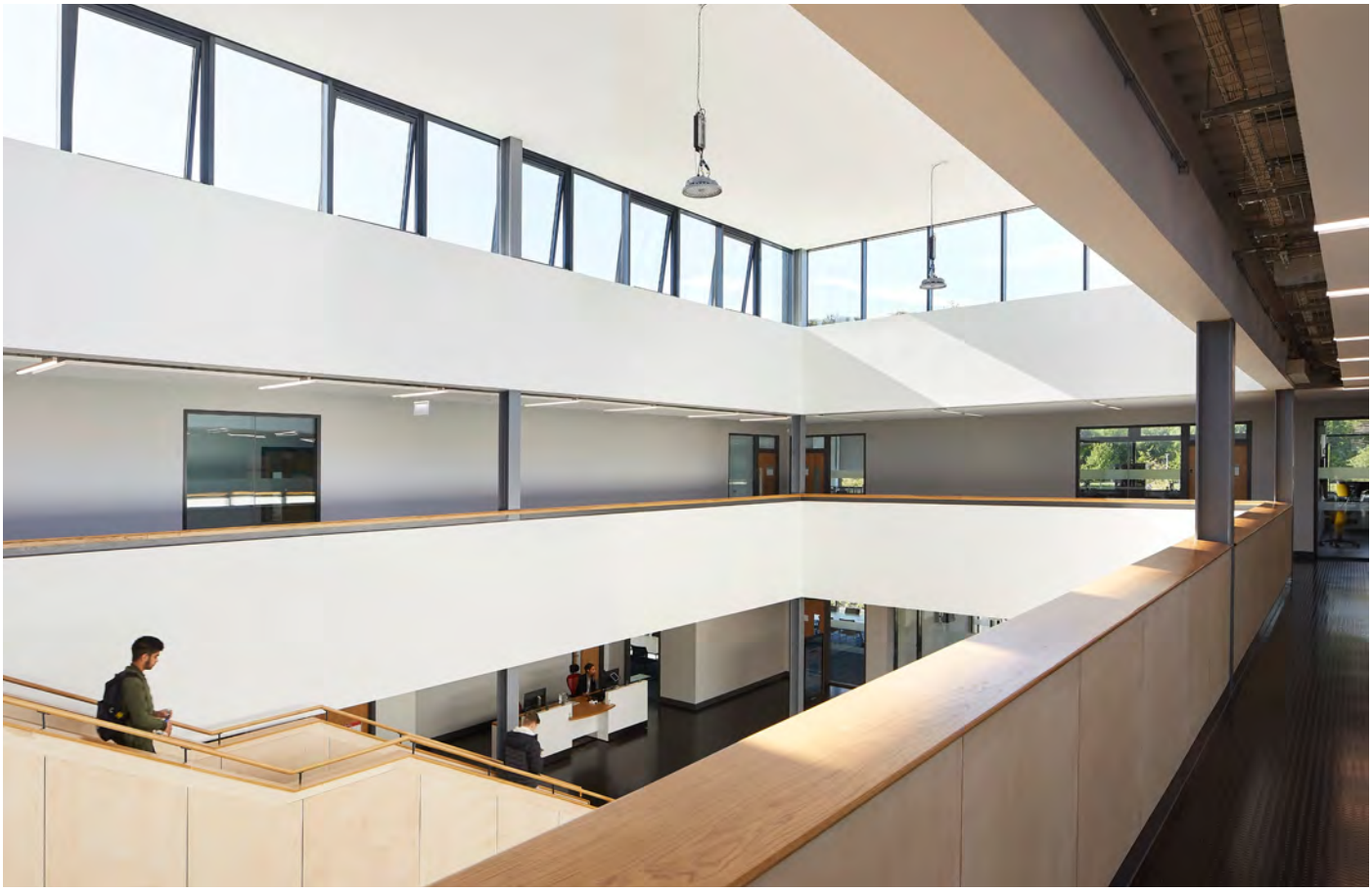
- as the design was being fully developed on digital twin, with most of the human input from the IPT already based remotely, it could and should continue apace, including regular IPT workshops, largely unaffected by Covid-19.
- There should be a second suspension, this time to the site enabling works (24 March) whilst the Government's position was clarified; but after 8 weeks they could re-commence in a sequence with just two contractors at a time - who could ensure distancing and the other operational procedures were followed.

Engagement of Suppliers

By this stage, 10 suppliers had been engaged and were actively contributing their product knowledge and logistics experience into the design development process, foreseeing and overcoming potential issues such as relating to power and water on site.

The traditional process of revisiting the design multiple times was therefore largely avoided. Off site, despite Covid-19, design development continued apace, including the selection of the remaining specialists. This was achieved by the issue of a quality questionnaire covering behaviours, alliance principles and "best for project" suggestions, and then follow up interviews. Awards were not governed by lowest price.

Since the majority of the suppliers enter into the "supplier alliance subcontract" with the constructor partner, we give the floor to Constructor Speller Metcalfe, Alex Garwood-Gowers and also M&E specialist contractor Derry Building Services, Joanne Lacey.



The Constructor's perspective

Experience on previous IPI trial projects has shown that there is still potential to unlock if suppliers are fully inducted and engaged into the collaborative alliancing environment. Efforts to improve in this regard on IoTT were frustrated by Covid-19. For a large part of Phase 2, it was mainly Speller Metcalfe present on site from the alliance, with the specialist M&E partner joining around the last quarter of 2020 – for good reason with limiting numbers. So the "flat structure" of the alliance partners wasn't readily apparent to suppliers, with some even missing out on the behavioural workshops.

We struggled on the IT front with certain suppliers, making engagement on design difficult with virtual meetings: some were simply behind the times, at a time when Teams/Zoom was essential, with those platforms innovating quickly for the benefit of all. Engagement from suppliers improved on site, following weekly progress meetings, where the wider team were in attendance and some suppliers were simply a 'better fit/choice' than others, with the best ones engaging regularly, buying into the process and as a result yielding savings in time, cost and general efficiency.

Once there is belief and trust in the process, you can see people relax and realise that the IPI process is not there to trip them up, but to facilitate them to bring suggestions to the table and work as one team. It is going to take some more time, not helped by the vast majority of projects still being traditional and adversarial.

The M&E specialist contractor's perspective

As we are normally a subcontractor, we understood why even those suppliers who have long-standing relationships with us will have been nervous about engaging via a supplier subcontract that is bespoke for IPI alliancing.

There was however general acceptance of the stepping down of the ethos and contractual principles, which shows not only an eagerness to work on the project, but also a willingness to trust, which the IPI contract facilitated, instead of fearing reversion to type. Next time we would spend more effort engaging with the supply chain and explaining what this form of contract means to them, with more inter-active workshops and explanations. Understanding generates confidence.

The IPI commercial model came into its own for us when the pandemic occurred, as it was the only project where we were aware of our full financial risk – at a time when sites were shutting, personnel were isolating, restrictions were being imposed, manufacturing was reduced, deliveries were delayed etc. the above cannot be understated.
Furthermore, on IoTT we noticed the less tangible benefits that IPI delivers, such as:

- individual professional development,
- encouraging everyone to have a voice,
- the "no blame culture", for example, we were in the midst of a pandemic and everyone rallied together to deliver the project, and
- great team culture, for example, there was the pressure to deliver the project, but it never turned to stress which is so often unfortunately seen.

IPI policy inception and commencement of Phase 2

Although the alliance board agreed that Covid-19 was a “force majeure” review event under the alliance contract, it recognised that its impact and duration were uncertain and capable of mitigation by collaboration. It was decided that further delay to the inception of the IPI policy and transition to Phase 2 should be avoided by dividing Phase 2 into two parts, with Phase 2A being limited to

- completion of digital development, with all necessary input from appointed suppliers,
- manufacture of elements such as steelwork,
- continuation of sequential site activities of ground remediation, groundworks, steel frame and floors,
- evaluation of the Covid-19 review event, including its mitigation,
- development of the project execution plan including SOI and acceptance criteria.

As already stated, in June 2020 the authorised funding for the investment target was raised to £17.359m inclusive of exceptional items, enabling the project with the Prototype Hub to proceed.

Progress on site continued in compliance with the Site Operating Procedures issued by the Construction Leadership Council, as revised to reflect the problems created by the Second Wave of Covid-19.

The effects of Covid-19 and the extent to which they could be mitigated were progressively evaluated.

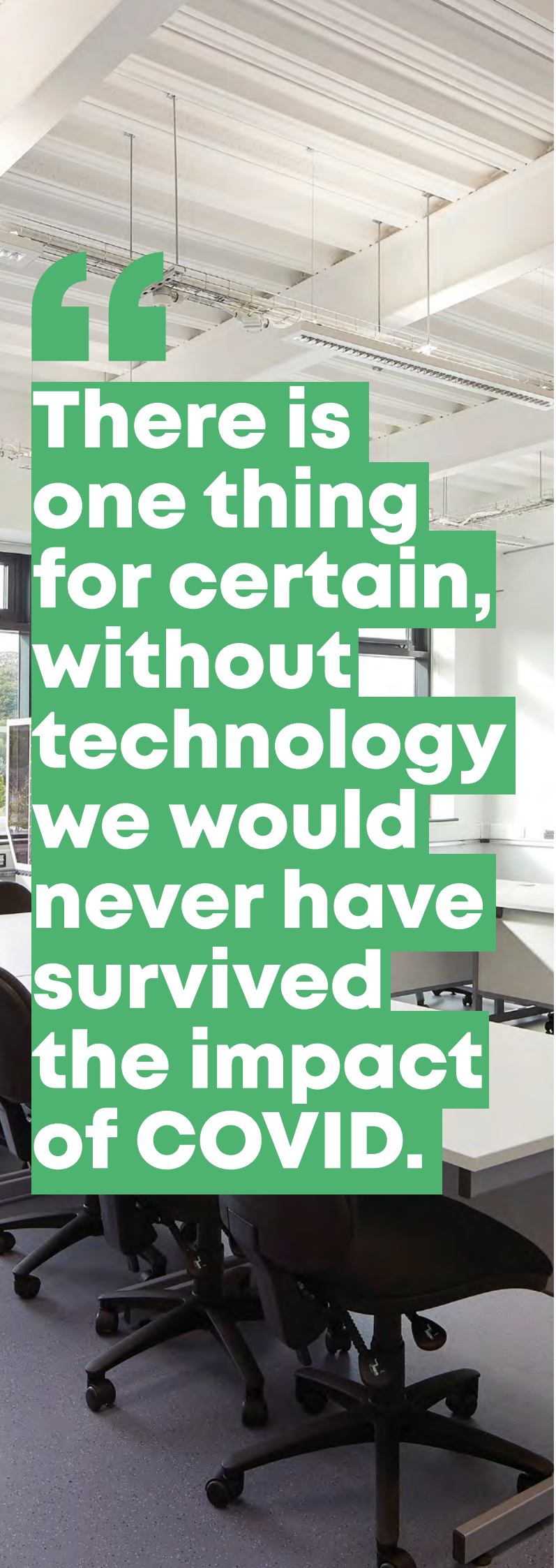
Meantime, the insurance industry was in retreat because of an array of incidents in the construction industry, notably the Grenfell Tower fire:

"The hardening of the construction Professional Indemnity market is now being seen in practice, with restrictions in cover having a serious impact on many companies and professionals in the industry. For some it may become unsustainable to stay in business, while those who can still procure PI insurance will face higher premium costs as well as restrictions in cover and higher excesses.

The Construction Leadership Council (CLC) survey results[6] *, published in March 2021, indicated that PI insurance premiums increased almost four-fold at the last renewal, having doubled the year before. This issue is essentially dividing construction firms into two camps—those who are willing and able to procure appropriate PI cover to undertake higher-risk projects, and those who are not.*

A quarter of the CLC survey respondents said they had lost work due to having inadequate PI cover, and it has also forced the same number to change the nature of their work in order to continue trading. Plus, many employers and their legal advisers are continuing to include contractual requirements which are simply not possible to comply with in the current market, and whilst some are willing to compromise, many of them are less flexible, which causes additional challenges to contractors[7]*."*

6. Press-Release-30-March-2021-CLC-PII-survey.pdf (constructionleadershipcouncil.co.uk)
7. Gallagher 7 September 2021



> There is one thing for certain, without technology we would never have survived the impact of COVID.

IPI policies, which cover all alliance members, their suppliers and any funders, do not include professional indemnity cover, which is blame/liability-based, and despite the general exodus, insurers were ready to engage and eventually incept the IoTT policy.

The level of cost overrun indemnity (above maximum pain-share/excess) was negotiated on a value-for-money basis, and it is noteworthy that the College was sufficiently comfortable with how opportunities & risks were handled on the first IPI project at Advance II that it did not require the same level of insurer indemnity on IoTT.

The figures agreed were:

Target Outturn Cost	£17,359,000	£17,359,000
Maximum gain-share allowed[8]		£1,000,000
Maximum pain-share chargeable	£875,000	
Limit of IPI financial loss policy indemnity	£1,750,000	
Extremes of potential outcomes covered[9]	£19,984,000	£16,359,000

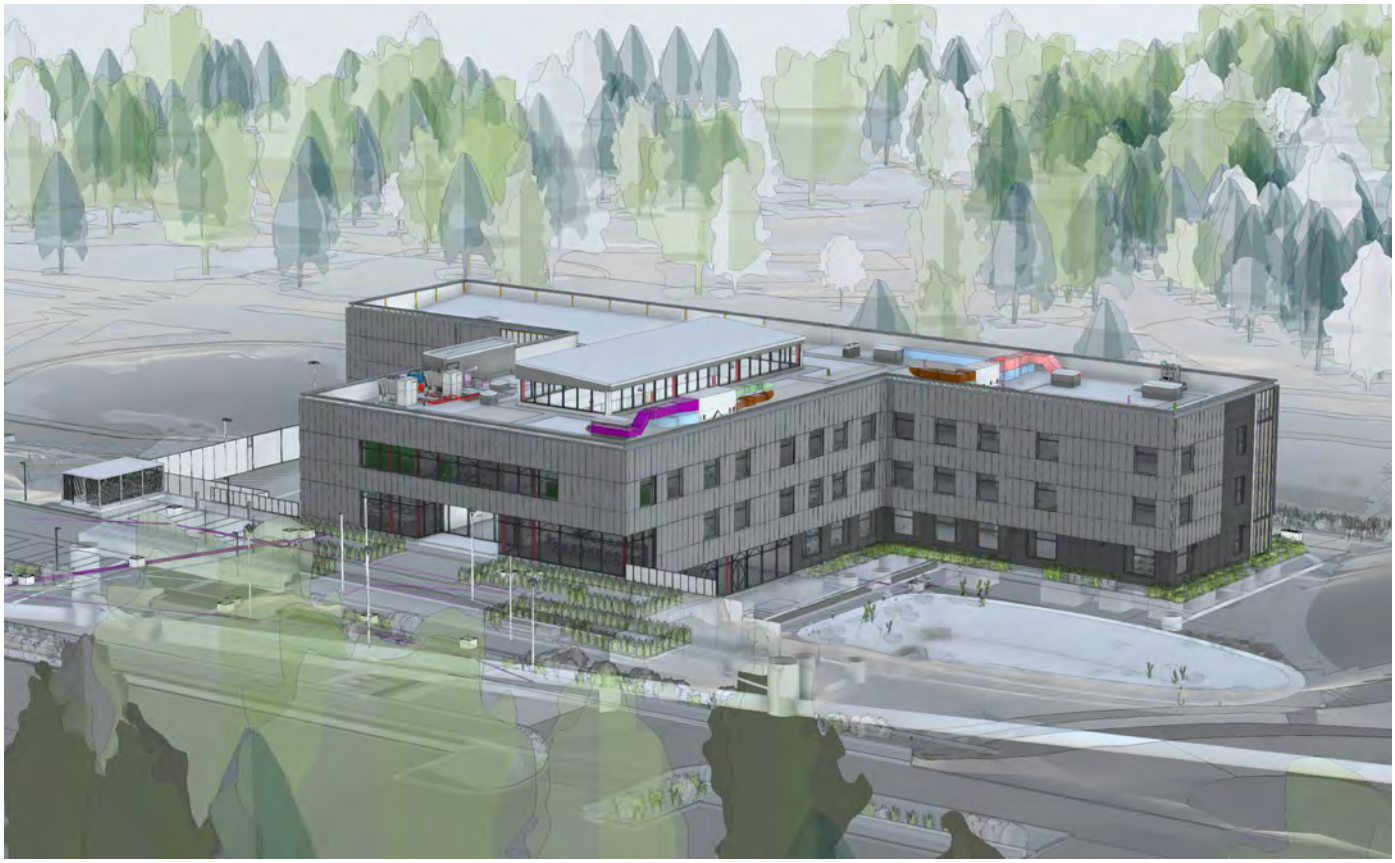
After endorsement of the solution and associated target cost by the Independent technical and financial risk assurers, together with confirmation from the independent facilitator that the alliance was collaborating as required, the complete IPI policy was incepted by the insurers with the concurrence of the College on 12 August 2020, and Phase 2A officially commenced on that day.

The usage of BIM and digital twin

Brief reference was made to BIM under Phase 1 and as we move from Phase 1 to Phase 2 more focus on their usage is appropriate. This technology is the particular responsibility of the Project Coordinator/Integrator under this alliance contract, but it was important at selection stage to know that all partners were familiar with its use, even if in different contexts. We therefore give the floor to Fulcro led by Sarah Hawkins.

8. This limit is to avoid motivation to make excessive savings against the benchmark
9. Any overspend above this figure would be to the College's account.

#Real life #Built asset #Completed building



#Virtual prototype #Digital Twin #AIM

The Digital Integrator's perspective

Exploded model view

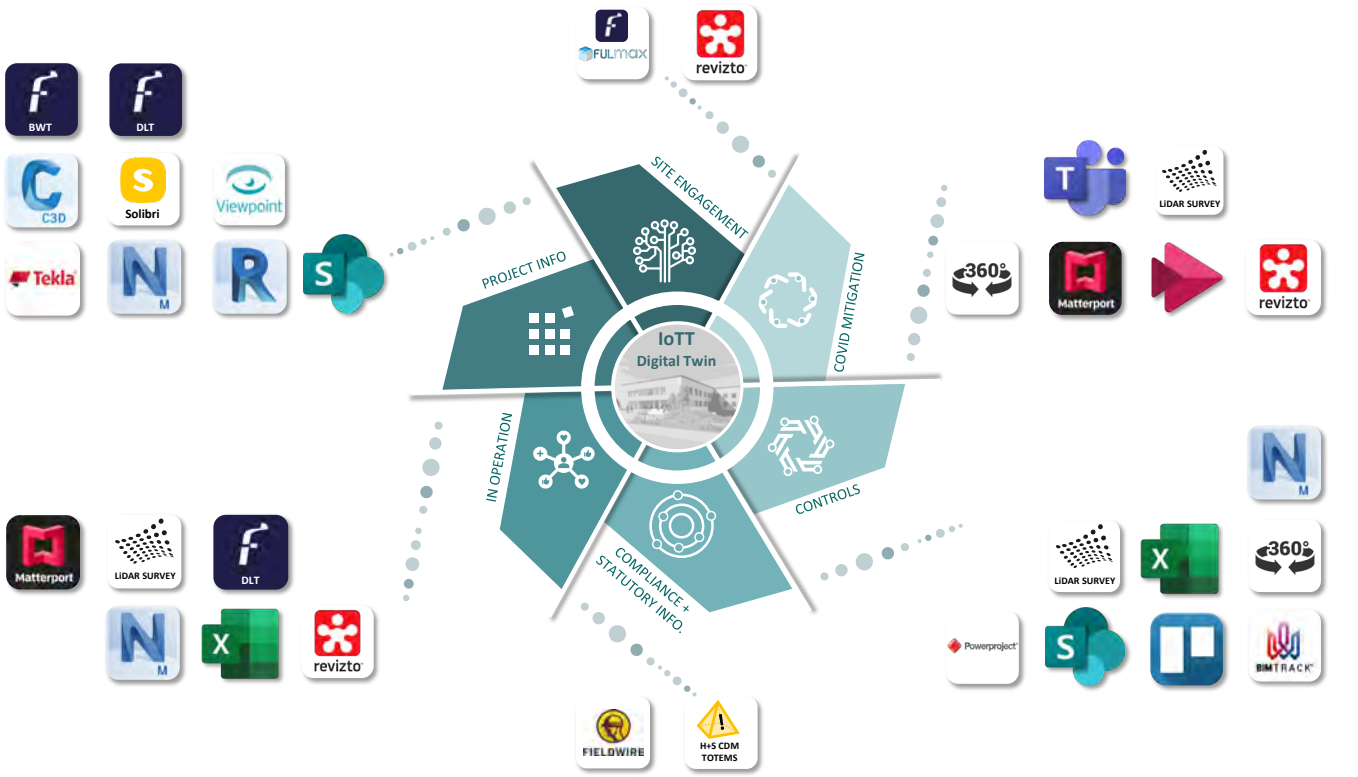
BIM related activities in Phase 1 were predominantly centred around capturing and defining the specific requirements of the project, and then agreeing as a collective how those requirements would be met, how they sat within the programme, and how they related to project costs.

They would also contribute to the success criteria for the project.

The targets for modelling in Phase 1 centred around providing sufficient information to inform the cost plan. They helped us identify the unintended consequences both in terms of opportunity and risk.

The digital prototype was also critical in facilitating stakeholder engagement, which was necessary to obtain the go ahead to enter the scheme for planning on behalf of the employer.

The extent to which digital twin has been used can be seen from the following diagram:



SITE ENGAGEMENT	COVID MITIGATION	CONTROLS	COMPLIANCE + STATUTORY INFO	IN OPERATION	PROJECT INFORMATION
Access to Design – Fumax **Induction** – FULmax **Remote Site** Progress - FULmax	**Site Visits** – Matterport, 360 camera + 'Not another Teams meeting' **Social Distancing** – Site modelling and walkthroughs	**Programme** – 4D / Build in a Day Workshops **Live documents** – SharePoint **Actions** – Trello **Coordination** – BIMTrack / FULmax **Cost** – Model QTO / Scheduling **Quality** – LiDAR Survey, 360 camera	**H+S** – CDM Totems **Compliance capture** – Fieldwide	IN OPERATION **Interactive asset register** – Hyper links embedded in register and model (change the register and the AIM can be sync'd **Field capture** – Model and database driven. Field data captured in shared Exel and pushed into AIM	**The usuals** – Revit, Tekla, Civils 3D, Navisworks, Solibri. **Plugins** – Fulcro Builders Work Tool, Fulcro Data Linking Tool **CDE** – ViewPoint + SharePoint

A practical approach to using technology:

It's important to recognise from the get-go that every individual's experience is different. The IoT alliance had varying levels of competency that had to be accounted for, to ensure a workable solution could be established for the project and supported holistically by the team. Understanding each team member's level of confidence and experience in interfacing with and adopting technology was critical.

Live digital working environments are not easy for everyone to embrace; users can fear exposure. Trust must be established, and as we know trust is something hard earned but easily lost. Building trust through behavioural workshops embedded a sense of 'team' from the outset; this fostered a collective willingness to 'give the unfamiliar a go' whilst being safe in the knowledge that 'stragglers would not be left behind'.

Essentially, we were going for what can only be described by those who embrace BIM under IPI, and the technology that surrounds it, as 'EXTREME COLLABORATION', not for the faint-hearted… everyone experiences in varying degrees their source code being over written, as traditional industry behaviours and habits are reprogrammed and replaced with new and more collaborative ways of working.

Technology enables the connectivity aspect of the BIM process, and alliancing facilitates the cultural metamorphosis, which in return enables 'extreme collaboration' to take hold.

Not everything that we attempted to put in place on the IoT from a technology point of view worked, but we continuously strived to improve. In some instances, the timing and introduction of a new process or new technology interface would impact its acceptance and use.

There is one thing for certain, without technology we would never have survived the impact of COVID. The team would have been fragmented, some isolated...with it we could continue being collaborative. The ability to integrate improved people's knowledge and skills, whilst also contributing to their health and wellbeing. In return this created a sense of value, a sense of community and importantly success.

We also made a conscious decision as part of our approach, to use and flex off the shelf technology, i.e. technology that we already used within our respective businesses; this was in an attempt to

ensure costs remained proportionate, and appropriate to the target cost plan, both in relation to licensing costs and the manhours that would be attributed to onboarding people with a type of technology they were less familiar with.

Creating the Digital Prototype

From the outset we established the asset requirements of the project. This was to ensure the deliverables including the digital twin were practically attainable.

We requested massing be used to identify spatial requirements where detail would later be added. This meant that, with clear communication, spatial zones were demonstrable, which enabled design to progress concurrently. So often we work on projects where MEP as a typical example is the 'tail end charlie', only to find the space left is insufficient to accommodate the kit and systems. Equally the impact MEP systems have on the structural frame can lead to the costly exercise of steel depths increasing and include the need for penetrations to be added.

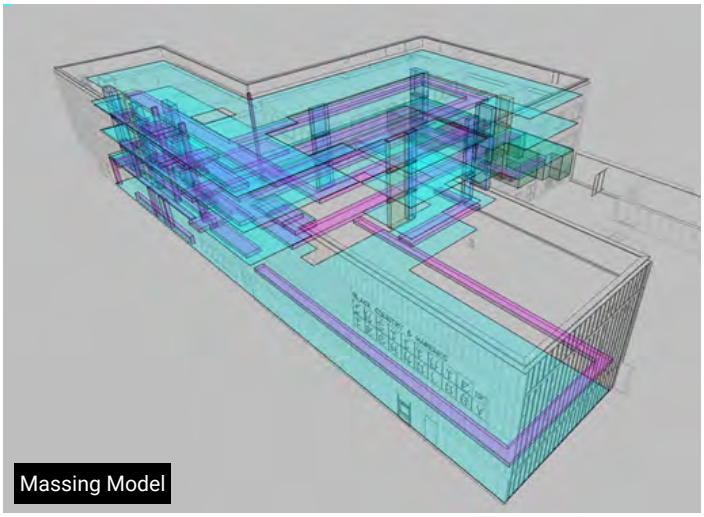
This impacts both the lead-in time for the procurement of the steel and drives cost in the wrong direction. Massing of this nature is largely overlooked in traditional project environments, but immensely important to supporting informed decision making and enabling the progression of the design at pace and within the target cost identified.

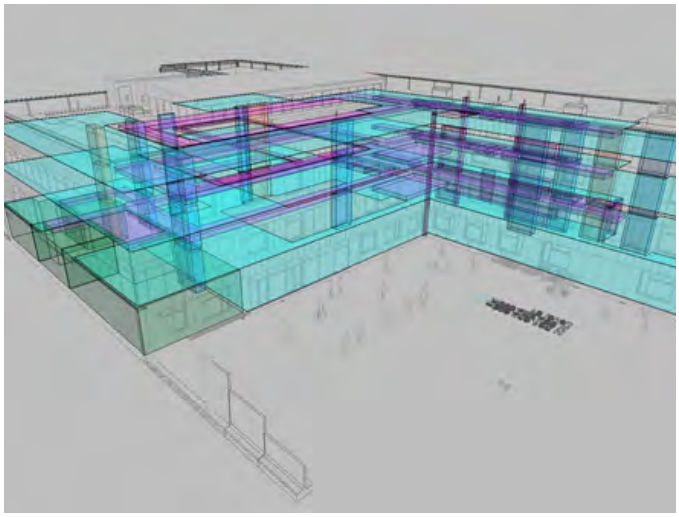
A desire to reduce the amount of paper driven documentation and drawing production across the project was a collective and conscious effort by the alliance team. However, it was incumbent upon us all to recognize and appreciate from the outset that there were various levels of confidence and experience with respect to working within a totally digital environment; we therefore set no hard and fast targets. We did, however, successfully remove almost half of the traditional exchanges of endless revisions and submittals between consultants and specialist contractors prior to the need for final construction information onsite. As much as we would have liked to reduce the extent of drawings produced further for the project, in preference to utilising the digital prototype, the reality that had to be faced centered around a large portion of the project's specialist suppliers still requiring them. However, by ensuring that suppliers joined our design review sessions, at the centre of which sat the PIM/ digital prototype, we were able to reduce the extent of hard copy information exchanged. Utilising the digital prototype in this way provided an increased level of understanding across suppliers, enabling decisions to be made 'on the spot', as opposed to gathering an endless list of actions to be dealt with later.

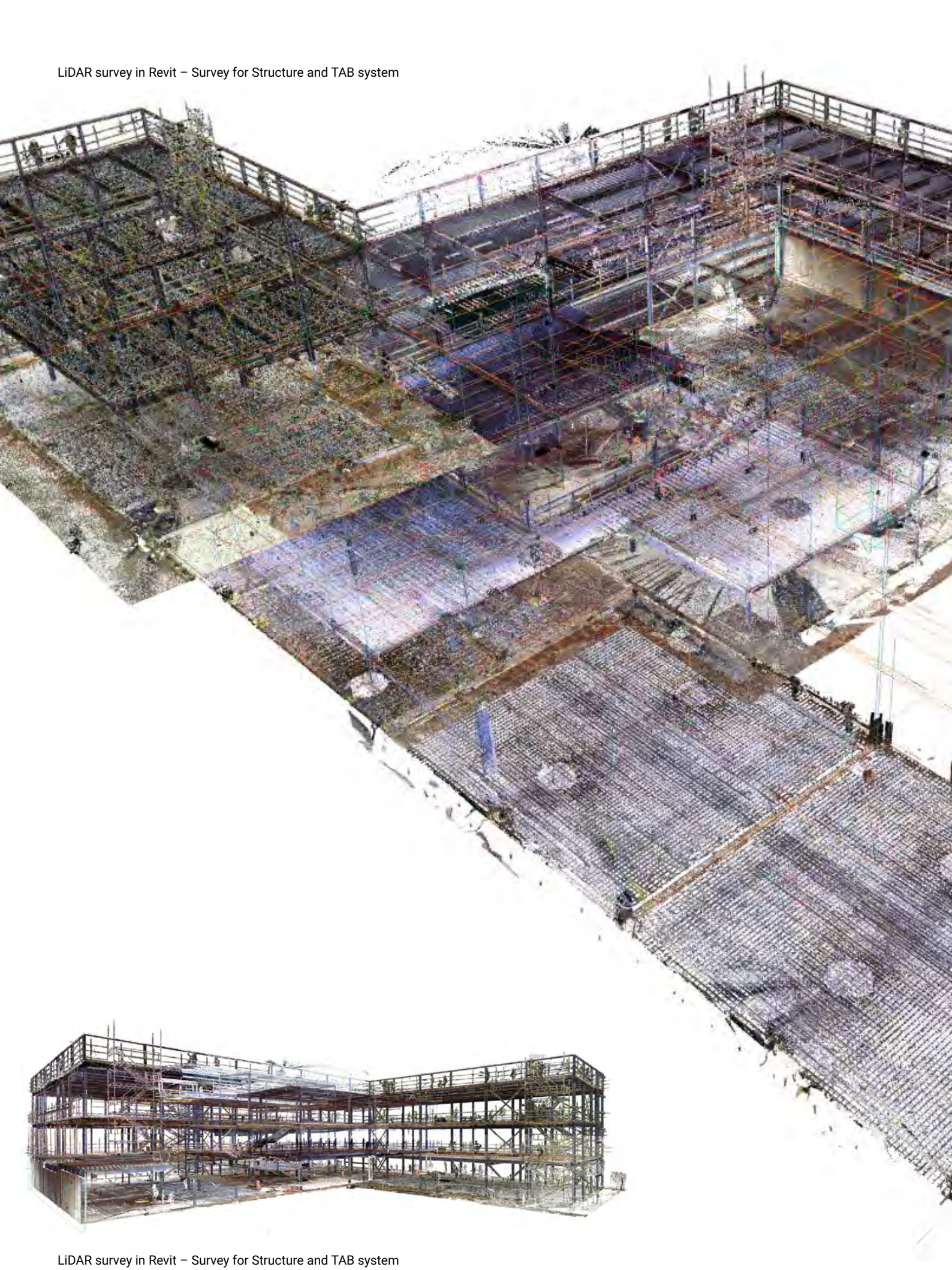
360 Camera Team – first time they had seen each other face to face since COVID began

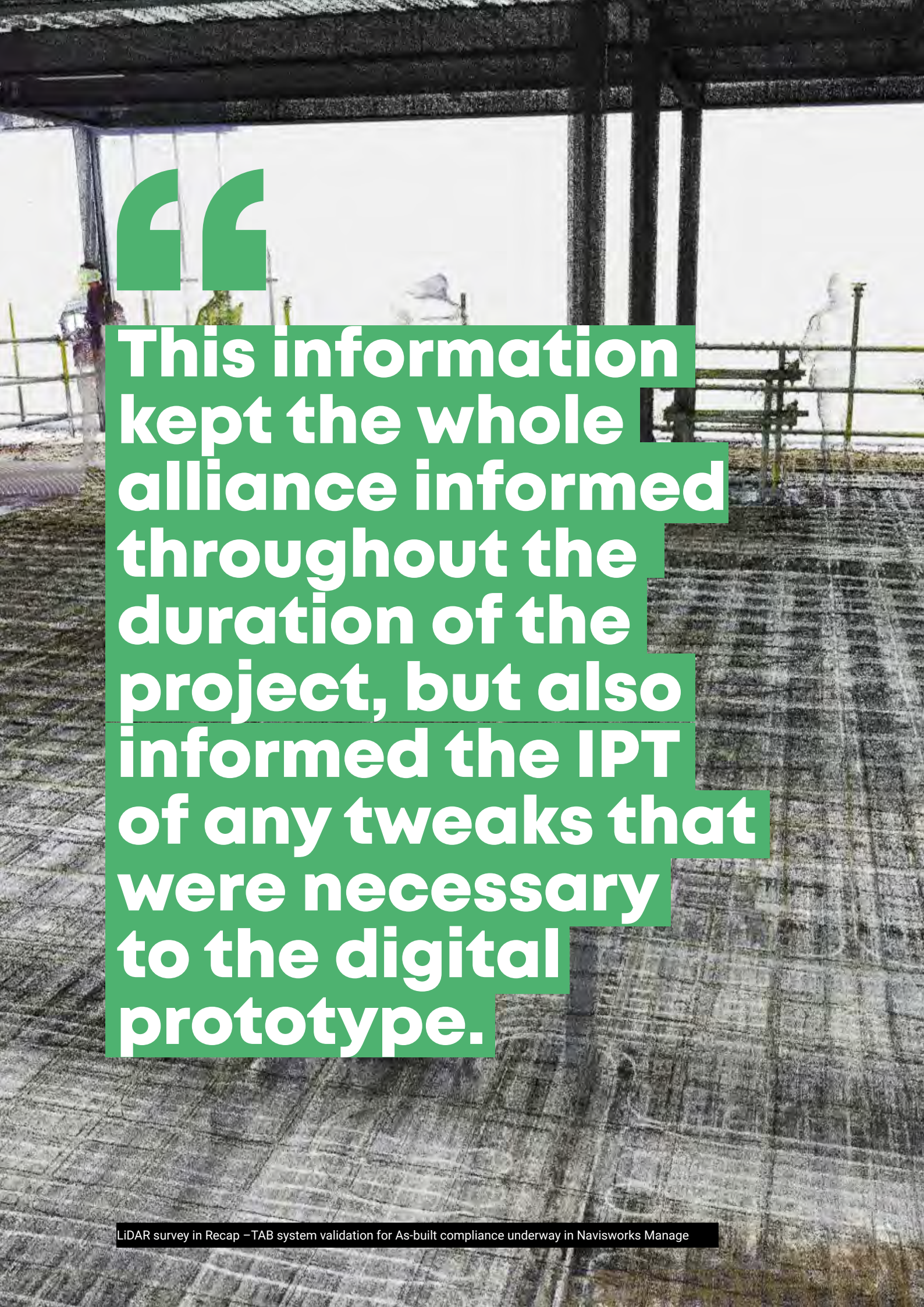
No 'red line mark-ups' proved to be a big win in this regard. None were produced on the project. The as-built information was not the rebadging exercise we are so familiar with. Instead, we carried out a range of validation through - Laser scanning, Matterport capture and 360^{o} photography. This information kept the whole alliance informed throughout the duration of the project, but also informed the IPT of any tweaks that were necessary to the digital prototype. The only record drawings that were produced were those specifically requested by the College for their O+M.

The Build in a Day workshops were held to promote wider understanding of the construction programme. To facilitate this the digital prototype's modelled elements were linked to the construction programme to provide virtual 3D visibility of the construction programme.


Massing Model

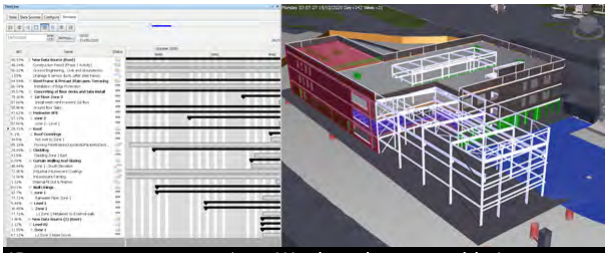






> **This information kept the whole alliance informed throughout the duration of the project, but also informed the IPT of any tweaks that were necessary to the digital prototype.**

LiDAR survey in Recap –TAB system validation for As-built compliance underway in Navisworks Manage



4D programme sequencing - We thought we would give Synchro a rest and try Navisworks Trimliner on this project

Using this 4D approach enabled debate and discussion with suppliers to ensure construction sequencing could be optimized between work packages, logistics and safe working zones could be tailored effectively and safely, responsibilities could be verified, along with providing an overview of how the IoT would be built day by day, which meant everyone was better informed and had a common understanding from which they could meaningfully contribute.

Contribution from the Constructor:

Collective buy in, collaboration and commitment from the suppliers was a key global win, getting the wider team in a virtual room together. More specifically, the sequence of cladding was changed, with it the off-site window fabrication plan was established to focus on the key elevations required to achieve water tightness.

The key water tightness driver focussed the team on design decisions to support the optimal sequence.

The façade was a high value item both in terms of curb appeal and cost. Different options for the façade were worked through at pace using the digital prototype, quantities were then drawn directly from the modelled elements and run as studies within the cost plan, in order that a recommendation could be made.

The responsibility to provide, and the value gained through training within our organisations should not be overlooked. A team that comes 'ready baked' possessing a more symbiotic relationship between their digital working environment as well as discipline, knowledge and aptitude, can only bring about meaningful change and contribute positively to our industry's tipping point, helping us to evolve and transform to meet future demands.

In return we will be better able to support our society and respond to global incentives that are centred around improving connectivity, sustainable and environmental outcomes.

The veracity that technology brings if we collectively integrate our experience and knowledge when forming solutions, combined with the many unintended consequences that will inform improvement and act as the catalyst required for continuous evolution, is desperately needed by our industry.

Lock down

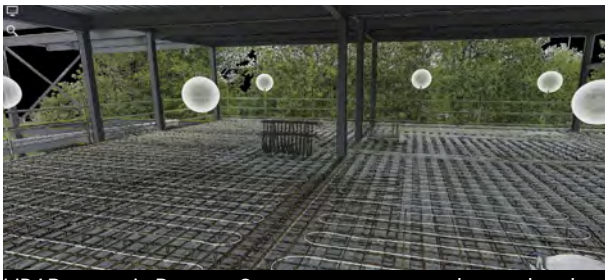
For all the upheaval and damage that's been created through COVID, the one thing we can be certain of, is that the costs of this crisis are high, way too high to go to waste.

No stragglers left behind… The first phase of lockdown led to our country rallying to help and support our NHS – with a 'stay safe', 'stay home' approach. Face to face meetings were completely off the agenda as we entered the unfamiliar.
As a project we had already committed to hybrid working which made our transition to fully enabled remote working a relatively painless one.

Our commitment to progress this project digitally, enabled us to be agile and to keep going throughout the lockdowns.

Engagement and connectivity with site progress was an area where we feared there being the biggest impact, and not just from a productivity point of view but also team morale. Keeping everyone informed and engaged, particularly those working remotely, became a point of focus for the IPT. If we couldn't bring people to site, then we needed to bring the site to our people. We planned and deployed surveying techniques sequenced to capture the structural frame, underground drainage and utilities, particularly so that pop-up locations could be validated against the design.

The instalment of the in-floor TABs system was also captured prior to screeding to validate exclusion zones.
We also deployed a 360^{0} camera on a weekly basis



LiDAR survey in Recap – Survey preparatory work to undertake TAB system validation for As-built compliance

that traversed the site to capture how work was progressing. This information was then mapped across into our Revizto environment, providing everyone across the alliance including suppliers a level of engagement and understanding that they

otherwise would not have had. You could even go so far as to say that it gave the team a level of engagement and visibility that was greater than would have been achievable under normal circumstances: the value of rolling back time using this type of technology came into its own many times throughout the construction phase - particularly when client change requests came into the mix, or a supplier's specification changed due to there being a material shortage.

As the building enclosed, we deployed a Matterport camera to enable a more immersive capture of the installation.

The above technologies and their application were invaluable in as far as productivity and maintaining programme were concerned. The connectivity the technology provided enabled us to maintain morale, providing a sense of community and involvement, as everyone battled through the challenges incumbent with lockdown and self-isolation.

Tools of the trade

A project team is made-up from a vast number of people with different but equally necessary and important skill sets. For some their tool of choice is the one that helps them to physically build something; for others it is the tool that enables them to create and communicate a design that has yet to be built. Not everyone has a laptop, iPad, tablet, latest mobile device, and not everyone has access to these types of tools. No stragglers - Engaging site operatives, with the latest technologies is all about winning hearts and minds, [remember these are the hero's that turn a consultant's vision of a design into reality]. Engaging with the trades directly to enquire what their frustrations are, what the biggest challenges are that they face, enabled the team to develop a practical response.

We provided massing zones within the digital prototype to communicate COVID procedures on site along with safe working zones across the site, kit areas and no-go zones. We used the model for site induction, and we placed a FULmax VR CAVE on site so that anyone who didn't have access to a laptop etc. wanting access to the virtual prototype following the induction, could gain access.
We didn't manage to win every heart and mind that came on to the site but when you walk into a site cabin and see a group of site operatives self distancing yet discussing an issue using the VR Cave each from different but interfacing work packages, debating the best sequence of activity, you know you've enabled something along the lines of what this industry needs more of.

FULmax VR CAVE -WIDE in the IoT Hangar

FULmax VR CAVE - CUBE in the site cabin collaboration and discussion led by Speller Metclafe

Contribution from the Constructor:

Reflecting on the project as a whole, I am 100% confident that if we did it again, we would see a significant step change improvement in a number of areas, not just in the evolution of tech during the pandemic, but greater trust in the IPI process. Thinking in the silo of Speller Metcalfe for a second and casting my mind back to March 2020 and re-starting site in May. Covid-19 and controls around that were a key priority and not something that is easy to measure, in terms of inefficiency and distraction! There was a significant mental strain for all involved on site, with new people attending site, regular concerns around infection and protecting all those on the site, I think this impeded communication, made worse by an internet black spot where the IoT is located! So for a period, the site was to a degree, isolated from the wider team and whilst the project was very much an overall success, I keep wondering how good it could have been....I am content with that, as it gives me a greater confidence in the process, even more under the circumstances!

Phase 2 to Completion

As planned, the effects of Covid – 19 and the extent to which they could be mitigated were progressively evaluated over the rest of 2020.

This staged process incidentally allowed for adjustments in staffing between the partners due to scope or programme refinements to be recognised, albeit without any change being made to the total "ringfenced sum" for the alliance's corporate overheads and profit.

Such flexibility after initiation of Phase 2, for a limited period while detailed design is still being completed and construction resourcing is being established, is clearly beneficial and steps have been taken to incorporate appropriate provisions into ongoing alliance contracts.

By 31 March 2021 the alliance board was in a position to confirm the basis for proceeding with Phase 2B:

- Target Completion would be extended by 7 weeks to 9 August 2021
- The Target Outturn Cost would be increased to £17.579m.

With the assurance of the preceding digital twin, construction on site proceeded apace. A number of events however arose which the partners accommodated, either because it was their responsibility under the alliance contract or because of the close alliancing culture with their client, the College.

Although some of the items were minor, they were potentially significant in the last 4 months immediately before completion:

- Alternative design and construction of balcony handrail and capping feature: a more robust and durable solution suggested by the carpentry supplier and welcomed by the architect.
- General material price increases (due to COVID etc), in particular the oak timber finishes; alternative features were designed and alternative materials were selected in some areas without detriment to the finished product.
- Flooding to external works areas due to failings of Severn Trent Water infrastructure 'up stream'; use of temporary pumps whilst STW resolved the issue, together with alternative sequencing of works.
- Sourcing of alternative bike shelter structure when the original supplier could no longer achieve agreed delivery date.
- Various adjustments to pond construction and finish to achieve acceptable aesthetic and maintenance regime.
- Accommodating a client request for a combined fire and security shutter, in place of a smoke curtain, to provide necessary out of hours security to close off the kitchen, aligning with elsewhere on the campus.
- Accommodating changes in use of some laboratory spaces which required service route alterations, with associated builders work and decorations.

The only events which classed as review events were late/insufficient power connection by Western Power and information flow for FF&E from the College, resulting in an extension of 2 weeks to 23 August 2021.This was still one month earlier than the "critical need" date in the original alliance contract.

Actual completion was achieved on 23 August 2021. Such was the status of completion and the handover in accordance with "soft landings" that IoTT was ready to welcome its first cohort of students in September and received Ministerial seal of approval with Rt Hon. Michelle Donelan MP, Minister of State for Higher and Further Education, officially opening the government flagship new centre on 21 October 2021.

Outcomes

The College's appraisal of the overall outcome was given by the Executive Director of Estates and Capital Projects:

"The College's bid for the Institute of Technology programme was based on the Integrated Project Insurance ("IPI") model of procurement and delivery in order to ensure the best value for money and predictability of outcome that was secured on Advance II, the College's first IPI project.

The outcomes on our IoT facility for advanced manufacturing, modern construction methodologies and medical engineering have been truly exceptional: the alliance's collaborative culture alongside use of a truly federated BIM model minimised set-backs from both Covid-19, as well as the more usual design issues experienced on a traditional project, especially on site.

Final design and build cost was about £58/m2 below the DfE's standard schools benchmark and about £130/ m2 below the bespoke benchmark derived for this complex facility; and running costs are already projected to be 62% below the Advance I building that was procured on traditional "design & build" to BREEAM Excellent standards.

IPI has transformed the College's experience with the construction industry, and we commend it to DfE and other departments that spend public money".

Outcomes in terms of Time and Cost are summarized below:

TIME	
Original Completion	21 June 2021
Review Events:	
Covid – 19	7 weeks
Power and FF&E	2 weeks
Extended Completion	23 August 2021
Actual Completion	23 August 2021
Critical Need Date (in contract)	22 September 2021

COST	DfE bench-mark	IoTT bespoke benchmark
Investment: Target Cost	£17.359m	£17.703m
Review Events:		
Covid - 19	£0.212m	£0.212m
Power and FF&E	£0.115m	£0.115m
Updated Target Cost	£17.686m	£18.030m
Actual Outturn Cost	£17.417m	£17.417m
Saving £m	£0.269m	£0.613m
Saving £/m²	£57/m²	£129/m²

Phase 3

The project is now in Phase 3 with a limited list of activities, mainly:

- Seasonal commissioning and operations support
- Sustainability reviews
- Reactive snagging and defects management
- Education and training

Phase 3 is due to be complete by 23 August 2022 but with the latent defects element of the IPI policy continuing for 12 years from completion.

Environmental, Social and Governance (“ESG”)

With investors’ recent recognition of the importance of ESG, it is pertinent to demonstrate the achievements on IoTT in these areas:

Environmental:
The success criteria required achievement of an EPC A rating and this was delivered. In accordance with the College’s energy monitoring, running costs are already projected to be 62% below the Advance I building that was procured on traditional “design & build” to BREEAM Excellent standards and almost exactly equal to the RIBA 2025 target. Embodied carbon is already better than the RIBA 2030 target. Both assume a target somewhere between those set for schools and for offices - *(see table on page 21)*.

Social:
When bidding to DfE for the funding for this project the College stated:
"The IPI new model of procurement applies an integrated collaborative working approach throughout to a level which exceeds any other previous procurement routes we have used". The alliance adopted the ethical principles of INSPIRE: Innovation, No blame, Shared vision, Passion, Integrity, Relish and Effective communication; and the principle of "no blame/no claim" was legally enshrined in the alliance contract.

Governance:
With decision-making being by consensus of the alliance board, all members were committed to their implementation. At bid stage, at the end of Phase 1 and at Completion, the alliance's commitment was to deliver a project "fit for the purpose defined in the strategic brief", and the alliance has had the comfort of knowing that this delivery has been subject to monitoring and review by the 3rd party independent technical and financial assurers throughout. Lastly, the routine of regular payments direct to partners and named suppliers, with prompt payment in turn to the other suppliers, underpinned ability to perform and obviated arguments and disputes.

Feedback from the alliance partners and their suppliers

This being project number 3 for me, I knew that as long as the right people were in the team the process would allow us to work together to tackle risks and problems but also realise opportunities when they were apparent. This though was by far the best and most efficient team I had been part of so far with IPI.

The transparency and openness enabled greater appreciation of what people were doing which meant you could engage with people differently. You potentially considered do I need to ask this and is this appropriate. Traditional approach you would ask/request everything to ensure you are covered. Open discussions regarding site difficulties/ problems. Having a beneficial input in product specification and procurement.

There was a great focus on the costs, even if certain individuals didn't see the cost plan as everyone's responsibility, the majority certainly did and by holding regular meetings to keep the team up to speed (usually including board members), I think the project team and board members had a greater understanding and appreciation of the cost plan - which ultimately paid them back with a gain at the end.

The most successful subcontractors in my opinion all fundamentally helped shaped their package in a positive way, constructive VM input and specialist knowledge was gained in many instances which often directly informed the route of travel. There are a number of success stories in this regard.

These subcontractors tended to be more engaged with the IPT (I believe we tried incredibly hard in this area with all subcontractors). In terms of the target cost of their package, the development of the pain/ gain mechanism at sub-contractor level seemed to be an area for improvement.

We can invest more time in aligning specialists in to the IPI Model and IPT to better utilise their skills and experience into project solutions.
Some of the suppliers that knew IPI engaged well with the IPT such as Walsh and Trad; others were non-existent. I think this was a mix of familiarity and the wrong people.

Whenever the Target Cost was showing as under threat or under pressure, the team reacted quickly to change that. I think the reporting of costs and cash was managed well which aided this, proving that a construction QS and a separate individual for the ACM role is certainly the way forward. I don't think the companies have to be independent for this to work, but the roles and therefore the people should be.

Had the alliance been as focussed on gaining opportunities consistently as they were at mitigating risk we'd have done better! Also programme was not given the same scrutiny as cost - we need a simpler way of reviewing - e.g. reason we caught up on some M&E is because the containment took 2-3 days not the 5 on the programme - we need to be as lean with programme as we are with cost.

We finished the project and from a site perspective I felt we were one team, not just as the alliance, but with a good percentage of the suppliers also. There was a sense of fun and more collective satisfaction from that achievement than I have felt previously.

As further evidence that the IBA experience is fulfilling, challenging but enjoyable a selection of sound-bites from the alliance partners and suppliers is included in Appendix 2.

More importantly, we see many areas where further improvements can be made. These featured heavily in our feedback session, and we hope there will be an early opportunity for us to take these exciting steps forward, yielding even better outcomes for the client and personal fulfilment for the team.

CONCLUSIONS

The overriding message, based on the experience of the IoTT alliance, is that the call for an eco-system of framework alliance contracts, framework sub-alliances, linked to a nexus of traditional or quasi-traditional contracts, indicates a legal solution to a long-standing practical problem.

Rather, liberate and empower alliances of competent organisations and motivated individuals to create and deliver solutions ever better to the client's needs, and reward them for their collective achievements. IBA doesn't simplify construction; rather it simplifies the management of its inevitable complexity.

It is to technology that alliances such as ours must look to support our vision for the future:

- Digital Twin, whose creators and developers[10] should respond to the need fully to integrate and simplify their many software systems, thereby transforming the performance of integrated teams. IoTT benefitted greatly from the adoption of BIM in the IPT from the outset.
- Value Toolkit[11]: we welcome the Construction Innovation Hub's development of this process covering the full investment cycle: need, optioneering, design, delivery and operation, recognising that there is currently "a gap between policy and performance".
- Modern Methods of Construction[12] : one of the success criteria for IoTT was: Highly efficient methods, including off-site manufacturing and new methods of construction are considered and where best for project used, in the design and delivery of IoTT eliminating waste in materials, processes and procedures. The extent to which MMC can be applied will vary between project types, and fears of "systemic failures" by insurers have to be overcome. Alliancing can offer an invaluable entrée by the inclusion of a MMC specialist as alliance partner, thereby involved from the outset.

Criticisms have been voiced that alliancing, such as with IPI, is unduly time-consuming and expensive in the early stages. One would have thought that the fateful rush to "get the spade into the ground" was a thing of the past. All the developments from which IoTT has benefitted and which are cited above as important to the future involve up front focus. The overview to the Value Toolkit expresses it clearly:

10. See for example Arup Digital Twin: "Towards a meaningful framework" 2019 Digital twin report.pdf
11. Construction Innovation Hub: Value Toolkit Overview April 2021 https://constructioninnovationhub.org.uk/wp-content/uploads/2021/08/ValueToolkit_OverviewDocument.pdf
12. Farmer "Modernise or Die" 2016 Layout 1 (cast-consultancy.com)

Alliance boards signing completion

The use of the Value Toolkit will strengthen the early phases of a project or programme. It demands considerable rigour in defining the outcomes to be delivered and understanding the client's approach to project delivery and risk, which will take time. But this will be more than offset by efficiencies realised in the design and delivery stages – ultimately leading to a better overall solution.

Collaboration is however key throughout. Without collaboration, teams will be impotent to benefit from the power of technology. Whether in the context of individual projects or frameworks, alliancing is key – because, as evidenced in this report - in its game-changing form at IoTT it enables "oven-ready" delivery of the Playbook's aspirations (repeated below):

One of the most effective ways to deliver outcomes is to create contracting environments that promote collaboration and reduce waste. Contracts should create positive relationships and processes designed to integrate and align multiple parties' commercial objectives and incentives.

Last and not least: as Government recognizes[13] , this transformation in both our procurement and our delivery will not come without intensive education and training.

13. Transforming_Public_Procurement-_Government_response_to_consultation.v3_.pdf (publishing.service.gov.uk) paragraphs 22 and 53 and The Construction Playbook – December 2020 (publishing.service.gov.uk) pages 3 and 66.

Explore the building via the Matterport Scan Link - https://my.matterport.com/show/?m=vT4uL3cr6p2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APPENDIX 1

Alliance Board
Dudley College – employer
Cullinan Studio – architects
GCA (UK) – structural and civil engineers
Cundall – multi-disciplinary engineers
Fulcro – digital coordination
Speller Metcalfe Malvern – constructor
Derry - building services specialist

Key suppliers introduced in Phase 1:
Traditional Structures: steel frame
MSW UK Ltd: structural floors
Uponor Ltd: TABS System (heating & cooling)
BC (Roofing Contractors) Ltd: external cladding
Dunton Environmental: ground remediation
Walsh Construction Ltd: groundworks
All Glass Systems Ltd: windows & curtain walling
Monarch Roofing Co.: roof system
Planet Partitioning: glazed partitions
Roskel Contracts Ltd: drylining

Other key suppliers:
Hadley Group: steel frame system
Independent Scaffolding: scaffolding
LCS Mechanical: mechanical labour
Monarch Electrical Contractors Ltd: electrical labour
H&G Carpentry: carpentry & joinery
Interior Décor Ltd: painting and decorating
Gladston Carpets & Flooring Ltd: flooring
Jack Moody LCE Ltd: Landscaping

Other parties:
IPInitiatives – independent facilitation
BLP Technical Services (UK) Ltd – technical independent risk assurers
Rider Levett Bucknall – financial independent risk assurers
Marsh – IPI brokers
QBE - Main IPI Insurers

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APPENDIX 2

"Good behaviours, coming together, still learning"

"Enjoyable - rewarding - better"

"Progressive, collaborative, game-changer"

"An inclusive team, with the opportunity to develop new skills, for myself and the wider team"

"Just Brilliant – want more"

"Work in progress - concepts are brilliant, needs more managing of people to achieve even more success"

"Challenging and Insightful"

"Positive, refreshing, collective focus, challenging, enjoyable, effective"

"Collaborative, enjoyable, unique"

"A step in the right direction"

"Inclusive, Collaborative, Engaging, Fantastic"

"The overall experience was challenging but satisfying when you consider the experiences that we went through as a team. A breath of fresh air when overcoming budget constraints"

"Collaborative, committed, enjoyable"

"I feel it worked well with a collaborative approach met from everyone I worked with on site"

"Very Interesting and good Education"

"A collaborative and team central process, succeeding through the challenges of the Covid-19 pandemic"

"Good initial planning and commitment but fell off"

"Positive, collaborative, innovative"

"Very good and rewarding, feeling very much part of a team - true collaboration. Found the digital experience fantastic"

"Ok, but maybe room for improvement"

"New, refreshing, engaging, enjoyable"

"Different and more captivating"

"Very good. But still more room for improvement"

"A good way of developing a construction project with involvement of all parties throughout"

"Collaborative - fun"

"New, hesitant, surprised, collaborative, effective, efficient, team building, looking forward to doing it again"

"Calm, Supportive, Grown-up fun"

"Thoroughly enjoyable, less stressful, collaborative, productive and successful. A breath of fresh air in an ever increasingly difficult world of construction"

"Thought provoking, steep learning curve, satisfying "

"Fun, Rewarding, Encouraging, Challenging, Educational, Collaborative"