

Integrated Project Delivery at National Highways

IPD

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CONTENTS

1. Executive Summary	1
1.1. The recommendations	2
2. Introduction.....	4
2.1. Method	5
2.2. The key characteristics of IPD	5
2.3. Enabling the change	6
3. Why use IPD?.....	9
3.1. It consistently delivers more of what clients want	9
3.2. Value definition - sustainability, buildability, usability, functionality, maintainability	11
3.3. Tales of two contrasting projects	12
3.4. Limitations	12
3.5. Conclusion.....	12
4. Where are NH now on the path to IPD?	14
4.1. What's good about what NH has done.....	14
4.2. Conclusion.....	15
5. What must NH do to progress?.....	16
5.1. System and structural alignment	16
5.2. Contracts and contract management.....	20
5.3. Leadership, culture building and culture management	27
5.4. Other considerations	40
6. Conclusion	41
7. Appendix 1: What is IPD?	44
7.1. The Goal of IPD	46
7.2. Tool based interventions vs a systems approach	47
7.3. What is involved in IPD?	47
7.4. What are the origins of IPD?	49
7.5. IPD Project Governance	50
7.6. Incentives.....	53
7.7. Some Defining Characteristics of IPD.....	54
7.8. Value Proposition.....	55

7.9.	Contract	55
7.10.	Agreeing costs and getting paid	57
7.11.	The Delivery Process	58
7.12.	Culture.....	60
7.13.	Collocation – Big Room.....	61
7.14.	Lean tools and techniques.....	64
7.15.	Target Value Delivery (TVD).....	64
7.16.	The Last Planner System of Production Control (LPS).....	66
7.17.	Choosing by Advantages (CBA).....	67
7.18.	A3 Reports	68
7.19.	BIM and other technologies	69
7.20.	IPLs: The client’s representative on an IPD project	69
7.21.	Project as a learning organisation	73
7.22.	Readings for IPLs.....	74
8.	Acknowledgements	77
9.	References	79

List of Tables

Table 1: What successful IPD clients do that NH does not.....	2
Table 2: List of IPD characteristics.....	5
Table 3: comparison of IPD and transactional project delivery practices	29
Table 4: comparison of IPD and normal transactional construction linked to recommendations.....	41
Table 5: key features of an IPD Project.	44
Table 6: List of desirable Skills, Knowledge, Understanding & Appreciations (SKUA).....	71

List of Figures

Figure 1: Percentage of projects on time and on budget or better	9
Figure 2: Effect of Inflation on IPD	11
Figure 3: Before (grey) and after (green) images from the project BIM of the new Turku Bridge	12
Figure 4: NH Progress Toward IPD	14
Figure 5: The Project Control Framework PCF - a critique.	17
Figure 6: mega-project management model.....	20
Figure 7: NH PCF Validation opportunities for starting both TVD and IPD.....	21
Figure 8: from RDP DIP Framework Instructions for Tenderers 23.04.18	24
Figure 9: Getting the Business Deal Right.	25
Figure 10: Timing of Key Stakeholder Engagement.....	28
Figure 32: Simple Mapping of NH PCF system to IPD/TVD.....	32
Figure 11: Integrated & ‘normal’ design processes	33
Figure 12: Selecting the right partners; deselecting the wrong ones.....	35
Figure 13: Value Creators create what the customer wants.....	37
Figure 14: Part of Deming's Quality Chain Reaction.....	37
Figure 15: Poster from the big room at UCSF Mission Bay Medical Center	46
Figure 16: Sutter’s five big ideas	47
Figure 17: Comparison of normal and integrated project delivery timelines	48
Figure 18: A generic project governance model.	51

Figure 19: Illustration of a governance structure in Australia.....	52
Figure 20: A project governance scheme for IPD projects	53
Figure 21: 10 biggest gaps between typical and best projects.....	55
Figure 22: Basic management structure of an IPD project.....	56
Figure 23: How do delivery partners get paid?.	57
Figure 24: IPD/TVD process flow	58
Figure 25: Cost of normal construction vs IPD using TVD	59
Figure 26: Behaviour reinforcement: DPR Meeting Ground Rules.....	60
Figure 27: Make the transition to putting the Value Creators on top	61
Figure 28: Collocation creates the pre-requisites for collaboration	62
Figure 29: Big Room at Sutter Health's Eden Valley Medical Center Project	63
Figure 30: Traditional point-based and set-based design. after: Kennedy 2003.....	65
Figure 31: Left: An example of the Cluster Groups on a hospital project Right: a cluster at work.	66
Figure 33: A3 report on a decision made using CBA	67
Figure 34: schematic for an A3 problem solving report.	68
Figure 35: A3s on a corridor wall in a big room.....	69

List of Abbreviations

A3	A3 Problem Solving; problem solving on a sheet of A3	see p. 68
AEC	Architecture-Engineering-Construction	
AGC	Associated General Contractors (of America)	
AIA	American Institute of Architects	
AIACC	American Institute of Architects California Council	
BIM	Building Information Model/Modelling	
CBA	Choosing By Advantages	see p. 67
CM@R	Construction Manager at Risk	
CMAA	The Construction Management Association of America	
CoP	Community of Practice	see p. 49
CURT	Construction Users Round Table (USA)	
DB	Design Build	
DBB	Design Bid Build	
DfT	Department for Transport (UK Government)	
DP	Delivery Partner	
DSM	Design Structure Matrix	
FTIA	Finnish Transport Infrastructure Agency	
HA	Highways Agency (a precursor to HE)	
HE	Highways England (a precursor to NH)	
IFOA	Integrated Form of Agreement (a relational IPD contract)	
IGLC	International Group for Lean Construction (a primarily academic community founded in 1993)	
IPD	Integrated Project Delivery	see p. 44
IPL	Integrated Project Leader	see p. 69
LCI	Lean Construction Institute (a primarily practitioner organisation founded in the US in 1997)	
LPD	Lean Project Delivery	
LPS	Last Planner System of Production Control	see p. 66
MEP	Mechanical, Electrical and Plumbing	
NH	National Highways	
ORR	Office of Road and Rail	
P2SL	The Project and Production Systems Laboratory, University of California Berkeley	
PCF	Project Control Framework	
PF	Project Facilitator	

PS	Project Steward
RDP	Regional Delivery Partnership
REM	Rapid Engineering Model
RFI	Request for Information
RIS	Road Investment Strategy (set by DfT)
SBCE	Set-Based Concurrent Engineering see p. 65
SES	Safety and Engineering Standards (NH)
SMPA	Smart Motorway Programme Alliance
SOFA	Statement of Funds Allocated
TIES	Transport Infrastructure Efficiency Strategy
TVD	Target Value Delivery see p. 64
UHS	United Healthcare System (a US healthcare provider)
VDC	Virtual Design and Construction
VFM	Value for Money

1. Executive Summary

Integrated Project Delivery (IPD) is a relatively new form of procurement that fuses together project alliancing and lean thinking, it delivers extraordinary performance when compared to traditional methods and is most suitable for high value, complex projects.

Noted by ICE under its Project 13 strategy, IPD is a system change for clients in the construction sector. A key differentiator of IPD is that it is directly **client led**, who's key role is to create and maintain a collaborative culture with an integrated team, during the design and production process. The quality of IPD leadership is disproportionately linked to project success.

The goal of IPD is to create a collaborative environment where team members **benefit from driving the cost down** whilst maintaining the agreed quality, scope, and programme requirements.

To gain a client leadership perspective of IPD please see the 2016 video [IPD Journeys](#) by Sutter Health's Vice President for Facility & Property Services, Bob Mitsch.

Prior benchmarking by TIES Living Lab identified that only 35% of National Highways projects were delivered on time and to budget in RIS1. This performance is comparable to the sector as a whole but clients that fully use IPD are reporting between 92% and 100%. A conservative estimate calculated during this research found that if RIS2 had fully deployed IPD £1.2bn could have been saved.

In 2017 Highways England's board approved the use of Regional Delivery Partnerships and the Smart Motorway Alliance. These procurement models adopt many of the principles of Integrated Project Delivery.

National Highways (NH) has made significant efforts to improve project delivery performance by introducing these collaborative forms of contract which incentivise suppliers to adopt lean construction but without adopting practices, processes and procedures that support this change. Consequently, these contractual changes have not yielded all the anticipated benefits.

NH efforts to date have been primarily externally focused, but not its own organisation or structure. If it is to transition to full IPD and realise the benefits, it needs to become an effective IPD client that actively mitigates constraints to co-creation of outcomes by integrating with delivery partners that it chooses for projects (S.4 & 5).

Therefore, the purpose of this report is to outline the actions that National Highways (NH) needs to take to realise the advantages offered by IPD as its preferred procurement route. It is about the whole system and not particular projects or frameworks.

This report recommends (S.5) that NH:

- **Align Structure and Systems** so all internal stakeholders focused on project outcomes.
- **Use IPD Contracts and lead and manage with the contract.**
- **Build Leadership, create and lead culture change** to support *Target Value Design and Delivery* from Project Control Framework (PCF) Stage 1.

This will take determined and coordinated effort with active support from senior leaders and investment stakeholders to assure success. If successful, the rewards will be significant.

NH has already made progress in this direction and there are many senior NH staff keen to practice their role aligned to full IPD. They appear willing to do the work to make it happen and they need a signal from NH Executive that it agrees and supports the necessary change.

Given that NH is already on a journey towards IPD, the key findings of this report highlight what successful IPD clients do *that NH does not*. These are summarised in Table 1. All are used by IPD leaders elsewhere. A more comprehensive list is included in Table 6.

Table 1: What successful IPD clients do that NH does not.

Structure and Systems Alignment	<ul style="list-style-type: none"> • Integrate systems • Insist on BIM on common data platform
Contract and contract management	<ul style="list-style-type: none"> • Use a multi-tier, multi-party IPD contract that fully engages specialist designers and constructors who can affect the success or otherwise of a project
Leadership, culture building and culture management	<ul style="list-style-type: none"> • Facilitate the Core Team within IPD project governance structure • Lead Target Value Design & Delivery (TVD) (see 7.15) • Make tough decisions when it is important to the team's success (Bryson 2010, 127) • Serve and support the value creators on the project with servant leadership • Create psychological safety across the project • Define decisions and facilitate decision-making using CBA with all relevant stakeholders • Develop leaders across the project • Provide and insist on big rooms/collocation • Foster a learning culture and manage moods on the project • On-board individuals and teams throughout the project • Facilitate working transparently

1.1. The recommendations

Recommendations should be read in context with the text that precedes them in S.5. and ideally with a deeper understanding of IPD found in appendix 1 but are summarised below.

Structure and Systems Alignment

- R1. Ensure that Delivery Partners' lead systems integrators fully understand and work effectively with NH expectations and requirements.
- R2. Conduct an internal "Systems Review" to build alignment to exemplary project delivery across directorates.
- R3. Review the use of all KPIs and KRAs to ensure they support desired behaviour.
- R4. Lead progress to a common data platform and require delivery partners to use it

Contract and contract management

- R5. Allow projects that have started to complete using their existing agreements and contracts.
- R6. Make NH frameworks flexible so that suitable individual projects within a framework can be delivered using IPD.
- R7. Decide what is the most advantageous incentivisation system for NH project and framework outcomes.
- R8. Adopt full IPD contracts when using IPD on projects with NH.

- R9. Ensure the designers and constructors responsible for project delivery are involved in Validation within the Target Value Delivery process for each project.
- R10. Ensure any member of a project delivery team that can significantly affect the outcome of a project can be engaged at the outset as a full delivery partner

Leadership, culture building and culture management

- R11. Develop from within and retain (or recruit and retain) suitable IPD project managers.
- R12. NH to take responsibility for facilitating Project Core Teams using IPD.
- R13. Invest in helping NH staff and chosen delivery partners learn IPD.
- R14. Insist on and lead Target Value Design and Delivery.
- R15. Require all delivery partners to contribute their fee (= overhead and profit) to an incentive pool that is at risk if the project team overspend.
- R16. Create client led collocation/collaboration hubs.
- R17. Insist on face-to-face co-location.
- R18. Use more structures, organised, and transparent decision-making techniques and systems to reduce opportunities for dispute.
- R19. NH must be willing to support tough decisions when they are important for project success.
- R20. Trust and verify delivery partners – and encourage them to do the same.
- R21. Create psychological safety across each project
- R22. Shift the focus of NH to supporting value creators.
- R23. Use Choosing By Advantages on all projects
- R24. Foster a learning culture and manage moods on the project
- R25. On-board individuals and teams throughout the life of each project

2. Introduction

Design and construction require diverse skills and knowledge, much of it tacit, that are widely scattered through the construction supply chain. Bringing all that information and all those skills together in the service of a client is a complex process requiring high levels of collaboration and teamwork. It is much easier to work effectively in teams when there are strong relationships based on shared values, shared goals and trust.

Repeat construction customers are aware of this and for years have been trying to tweak the procurement process they use to improve the service they get from their construction supply chain. National Highways (NH) is no exception.

IPD represents the current state of the art in terms of project safety, delivery, cost and environmental performance for high-complexity and high-value projects. IPD is well known to parts of NH but there are also large gaps in knowledge. IPD is a continually evolving way to procure construction that NH aspire to use to deliver results while reducing cost and improving outcomes for the whole team.

For over ten years NH has actively sought to procure more collaborative delivery teams using lean construction strategies from its construction supply chain. This has been supported with significant investment in internal and external resource, together with innovative forms of procurement such as RDP and the Smart Motorway Alliance. NH are a member of the SMP Alliance and chair the board, have people in senior leadership positions and NH Project managers are members of project leadership teams.

Despite this, research suggests that much of NH's efforts are still externally focused, using contractual mechanisms, audits and key performance indicators to encourage better performance from the supply chain. To get the results NH wants it must focus on its internal alignment, behaviours and willingness to lead the transition it wants to see on its projects.

During 2022 a DfT sponsored innovation project, TIES Living Lab, carried out a lean process benchmarking study. As NH was part of the Living Lab consortium, it actively took part, contributing both data and internal resource. To create a meaningful benchmark, an exemplar lean construction client organisation was identified with which NH could be compared. This organisation was Sutter Health, a relatively small not-for-profit healthcare client serving Northern California. The Sutter project delivery performance is extraordinary.

Between 2007 to 2019, Sutter completed 24 projects for \$4.7 billion. Overall, 5% under budget, with a success rate of 92% on time (or better) **and** on budget (or better) with no scope compromises. This compares with a construction sector average performance in the USA of only 30% of projects delivered within cost and schedule goals. Other clients have followed suit and report similar results.

The percentage of NH projects both on-time and on-cost or better in RIS1 was just 35%. Moving from a 35% good to >90% good performance might sound like wishful thinking, yet there is good evidence that it is not.

The TIES Living Lab researchers set out to compare the NH delivery models with *Integrated Project Delivery* (IPD) used by Sutter. This revealed significant differences and highlighted that whilst NH have embraced some aspects, it has yet to embrace others that are critical for success. Some NH senior leaders did not understand IPD.

2.1. Method

During 2023 NH commissioned further investigatory work into IPD including:

- A select literature review to help define the client characteristics of IPD.
- A Study Action Team for senior managers from within NH and select partners, to improve understanding of IPD.
- A Study tour to Finland to examine IPD on live projects. These included projects being delivered by the Finland Transport Infrastructure Agency (FTIA) and were directly observed by key NH senior leaders. Whilst the USA and Canada would have also been appropriate Finland was selected due to track record with IPD in infrastructure and close European connections/similarities to the UK.
- Interviews with NH staff and suppliers to help understand the current gap between the status of successful IPD clients and NH (n=30).

This report is the culmination of that investigation.

2.2. The key characteristics of IPD

IPD is complex and there is a fuller description in Section 7

The following summary of IPD characteristics were identified in the literature review (Table 2). They attempt to explain IPD on two pages by comparing it to *normal transactional* practice in the construction sector – i.e. commonly used procurement strategies such as design-bid-build. Most of the characteristics are drivers of change, but 6 are results or manifestations of IPD. These are marked with an *. NH are not specifically compared in this table as it simply attempts to clarify what IPD is.

Table 2: List of IPD characteristics

	IPD Characteristic	Normal Construction
Value Prop'n	Value is defined (and deployed with metrics) from four key stakeholder perspectives. Sustainability, buildability, useability, operability.	Minimise first cost
Client involvement	requires greater client involvement particularly in early stages of project – see page 58	Brief and monitor; respond to
Contract	Profit and cost are separated	Profit is a proportion of cost
Contract	Early involvement of key participants	Those that build don't provide design input
Contract	Delivery partner costs are guaranteed to completion	Varies according to contract type - often no guarantees
Contract	The organisations that will do the construction are actively involved in the design	The people that do the work are procured after design is done
Contract	Limited entitlement to variations	Costs are hidden
Contract *	Money can move easily across boundaries (between parties)	It can't move or it is very difficult to move.
Contract	Jointly developed and validated meaningful metrics that reflect client value	Uncertain or no metrics
Contract	Shared risk & reward across all key parties (win - win)	Transfer of risk (win-lose or lose-lose)
Contract	Financial Transparency – Open Book. Parties can see each others' costs	Costs are hidden
Contract	A single multi-party contract - client, designers, tiers 1 and 2 with shared risk/reward. Whole team contractually bound to a common goal	Many individual contracts
Contract	Liability Waivers	Parties are individually liable

	IPD Characteristic	Normal Construction
Contract	Single Project Insurance	Individual party insurance
Contract	Collaborative decision making as close to where the work gets done as possible	Remote decision making - often not visible
Contract	Suppliers procured mainly on level of expertise/capability	Suppliers procured based on cost
Culture*	An organisation focused on achieving a successful project	An organisation set up to avoid individual failure/risk
Culture*	The parties involved in the project behave as if they were one company	They parties look out for their own interests first.
Culture	Client defines values & goals so entire team can understand, quantify & track what they are working toward	Some of the team understand.
Culture*	Mutual respect & trust	Varying degrees of trust
Culture	Physical collocation space to work in (Big Room)	Remote or infrequent physical contact
Culture	The client is an equal member of the delivery team	The client delegates lead role to a consultant or contractor
Culture*	High willingness to collaborate	I'll collaborate if you pay me and I won't lose anything
Culture	Face to face interaction	Remote
Culture	Client prepared to replace "Rotten Apples"	Make do with poor behaviours
Culture*	Team openly acknowledge errors and expose mistakes to protect the project.	Team hide problems to protect themselves
Culture & Process	Rapid continual improvement & learning-incremental & breakthrough. Identified improvements acted upon quickly	Limited ability to implement improvements
Process	Systematic validation of owner business case by the team	Receipt of written brief
Process	Effective Collaborative Production Control with Last Planner System (LPS) - generally with Takt planning	Unreliable Critical Path Method plans
Process	Production system designed alongside product design	Production system deigned after product design complete
Process	Use of Target Value Design	Design then price
Process	Extensive use of decision-making tools such as CBA and A3 Reports	No agreed methodology for decision making
Process	Design change decisions are typically made by the team in less than 1 day	Design change decisions take several weeks
Tech	Visualisation extensively used for prototyping to avoid errors	Some visualisation but allows many errors through
Tech	Common data environment that works	Common data environment but works poorly
Tech	Effective use of BIM	BIM

2.3. Enabling the change

To enable the step change in performance gained, required Sutter to do two things:

- rethink its own role as a construction client in project delivery, along with its internal capabilities and revised contractual mechanisms.
- Help its delivery partners and those who wanted to become delivery partners rethink their roles within this new way of working.

If NH is to realise similar benefits in terms of cost and delivery performance, it also needs to begin by reviewing its own role and capabilities as an IPD client.

Construction performance is often compared to manufacturing, yet it is significantly different. The '*peculiarities of construction*' include (Koskela 2000):

- Temporary Organisations (constrained procurement practices)
- One-of-a-kind / bespoke projects
- Fixed position production (resources move across product)
- Rooted in Place (site-based operations/local conditions)
- Client involvement in the design and production process (decision making)

IPD deals with these peculiarities and builds on:

- what is now known as Project Alliancing – a procurement process developed by the UK chemical engineering construction sector in the early 1990s and subsequently in the North Sea and Australasia
- the work of the founders of the USA Lean Construction Institute,

In 2004 Sutter Health decided to use what we now know as IPD to help it recruit delivery teams in a highly competitive market dominated by much larger healthcare clients. It had previously struggled to secure delivery teams to deliver its projects at a reasonable price.

To make this work, Sutter realised it had to change its internal organisation as well as develop the skills and competencies of its potential delivery partners.

Initially using Target Value Design (TVD) and lean thinking, it was able to simultaneously reduce construction costs while delivering projects greener, faster, with more scope and more safely at 10-15% lower cost — a step change in construction performance. In 2005 it began using a bespoke new contract, the *Integrated Form of Agreement* (IFoA). Sutter's lead is now followed by public and private sector organisations across the USA, Canada, Australasia, Hong Kong, China and in several European countries led by Finland.

In short Sutter is considered the lead organisation in productivity change in construction. IPD is at the heart of that change.

Civil Engineer David Kelly's **5 screening questions** (2021) below and key points for a prospective IPD client are a good place to start a conversation about doing what it takes to fully adopt IPD.

5 screening questions for IPD for clients.

- Are you happy hiring the designer, constructor and key specialist trades using an uncapped reimbursement model?
- Are you prepared to engage virtually full time in the overall management of the project as a participating, active team member?
- Do you believe that better results are achievable through intense team integration?
- Are you comfortable that the designer, constructor, and key specialist trades have near-equal say in decisions about products, materials and specifications?
- Are you comfortable paying bonuses and other incentive payments to the designer, constructor, and key specialist trades if the key performance indicators (KPI) are achieved? Are you still comfortable doing this, even after implementing cost reduction measures and value engineering (VE)?

(Kelly 2021)

NH may be inclined to say **no** to one or more of these questions. In the early stages of its transition, so did Sutter (Mitsch 2016).

If you are inclined to say no to any of these questions it may be helpful to read *Appendix 1: What is IPD?* and watch the 2016 video [IPD Journeys](#) by Sutter Health VP for Facility & Property Services, Bob Mitsch (30 min presentation, + 15 Q&A).

Kelly expands on the five key questions with these key takeaways from multiple IPD engagements.

- Importance of **behavioural change**
 - *especially* on the part of the client.
 - Cultural norms are a *barrier* for improved outcomes.
- **Trust** – non-IPD mindsets must be discarded.
 - Were all partners now!
 - Trust but verify – importance of audit.
- Client has more **risk** than in the traditional model.
 - Project cost is not stipulated or guaranteed.

NH aspire to a level of performance similar the that achieved under IPD and is already moving in that direction as outlined in S.3. The supplier focused actions taken so far have not yielded the benefits that flow from full IPD.

This report is organised:

S.3 Why use IPD?

- This section explains the benefits of IPD

S.4 Where are NH now on the path to IPD?

- This section presents where we believe NH currently are on their journey.

S.5 Recommendations: What must NH do to progress?

- This section discusses the issues we found and makes recommendations:
 - Outlines what NH is currently doing in key areas and ...
 - describes the most important things that NH needs to do to progress.

S.6 Conclusion

Appendix 1: What is IPD?

This appendix is recommended reading for people who want or need to know more about IPD and how it works. It describes IPD as concisely as possible.

3. Why use IPD?

IPD enables shorter programmes delivering greater value with less problems than the normal approach.
Ward & Mossman

3.1. It consistently delivers more of what clients want

The case for IPD is straightforward. IPD consistently delivers more of what clients want with better **quality** at **lower cost** and in a **shorter timeframe** with a **more sustainable** delivery and operating profile. The IPD process improves participant wellbeing and is proven to be a **safer** and **less stressful** working environment, creates **fewer changes** and delivers work **right first time**.

IPD outperforms other construction delivery models in terms of:

- Projects delivered on-time and on-budget *or better* (see Figure 1)
- Environmentally sustainable performance and lower carbon
- Scope delivery and functional effectiveness
- Quality outcomes with right first time in design and delivery
- Buildability, usability, functionality and maintainability of the asset.

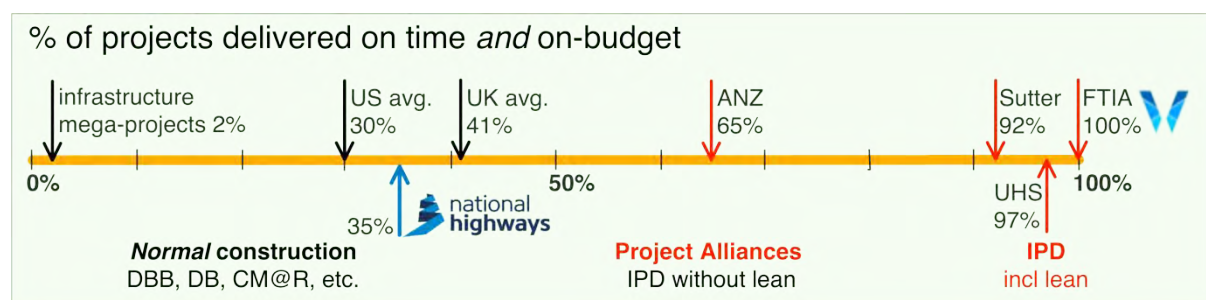


Figure 1: Percentage of projects on time and on budget or better

Explanation of data in figure 1.

- **Infrastructure mega projects** on time *or* on budget – Companies public annual report; HIS Herold Global Projects Database, November 19, 2013, press release. Widely quoted. (a mega project is defined as >\$1bn)
- **USA.** Construction Industry Institute research data 2012 Sample of 957 projects avg. \$65mil.
- **NH** – sample of 24 projects (CPI & SPI data) reporting period ending March 2019 provided by commercial intelligence team
- **UK Average.** Calculated from Glenigan 2018 data for all Non – Housing Construction.
- **ANZ:** 61 Australian and New Zealand Alliance Projects, 85% on- or below budget, 76% on-time or better, little or no use of lean thinking. (Walker, Harley and Mills 2015)
- **Sutter.** Between 2007 to 2019, Sutter delivered 24 projects for \$4.7 billion. Overall, 5% under budget, with a success rate of 92% on time (or better) and on budget (or better) with no scope compromises.
- **Ashcraft (2022).** 36 IPD projects, average value US\$102mil (max \$1.5bil); 94% of projects were delivered within the client's budget; 94% of 88 survey respondents said they would use IPD again — including those where there was a project cost overrun.
- **United Health Services (UHS).** Sample of 40 Projects between \$2mil and \$150. Between 2007 and 2014.
- **Finland Transport Infrastructure Agency (FTIA)** 10 IPD projects 2011 to 2022 avg. value €81mil.

The desktop literature review further supports the business case for IPD and provides strong evidence that it is a superior project delivery system. This research found many rigorous papers that provided quantifiable results. A good example comes from Ashcraft (2022b), based on an

extensive review of IPD performance evidence it goes on to critique other studies that have attempted to quantify success or failure.

Experienced repeat-build clients that use IPD report average overall budget savings of between 5 and 6% [= £100-120m p.a. for NH]. Normal construction includes many *non-value adding* transaction costs. Bill Seed has estimated that up to 50% of construction costs are transaction costs (Seed 2012; 2013). The UHS Temecula Hospital project was delivered early for 60% of the Allowable Cost. Working in a crowded healthcare market in Northern California, Sutter benchmark the prices of the facilities they want against those delivered to local competitors and then ask their delivery partners if they can deliver the project around 10-15% below those achieved by competitors. Frequently Sutter delivery partners agree that they can. This means that the real savings can be even more significant.

“RDP used IPD and when tendered showed a conservative 3% saving of £1.2bn. But NH process, procedures, and behaviour did not change to support IPD, resulting in the current overspend.”

Interviewee

In 2018 when RDP was let, the financial models tendered were applied to the schemes being let from RIS2 and compared to the CDF priced model showed that delivery could yield £1.26bn of savings. As NH then failed to implement IPD and, more specifically, Target Value Design (TVD), those savings have been lost to transactional custom and practice.

IPD removes dysfunction caused by traditional transactional business and contract structures replacing them with structures that encourage collaborative co-creation, sharing, and trust which in turn drives collaborative, creative and effective high-performing teams (Ashcraft 2022b).

If RIS2 had used IPD and delivered a conservative 3% saving (instead of the current forecast cost overrun), £1.2bn would have been saved.

IPD can deal with inflation.

It is debatable whether inflation should be included in construction cost estimates and who should bear this risk. (Chapman, 2022)

The Sutter Cathedral Hill Hospital (now known as the CPMC Van Ness Campus) was first designed using a design-bid-build contract and tenders came in way over the \$911million budget. Rather than continue with that process Sutter decided to start again using IPD. Figure 2 shows the progress of the predicted cost over time following the validation phase of IPD.

The initial cost estimates from the new team did come in well above the allowable cost agreed with Sutter. This is perfectly normal in the context of a *Target Value Delivery* process using IPD (Bill Seed says it is indicative of the health of the project team). After that the estimated cost gradually reduced as constructors' confidence in the quality and buildability of both the facility design and the production system design increased and as the amount retained as “contingency” falls. It is noteworthy that the IPD process coincided with a period of high inflation (see lower graph), yet this was absorbed and the team was able to add more scope from the client's *wishlist*¹.

¹ The client's wishlist includes “nice to have” items that the client would like added to the project scope if the budget allows

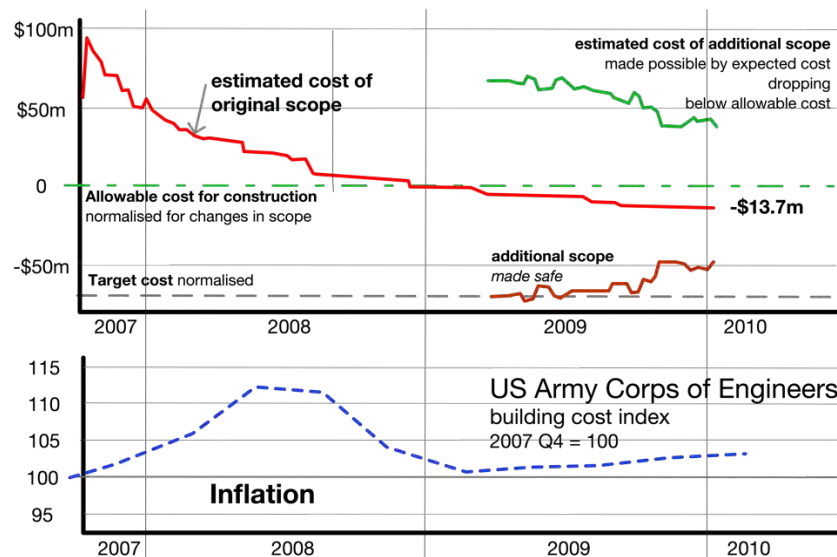


Figure 2: Effect of Inflation on IPD. Top: Successful TVD implementation decreases cost over time. This is an example from the Sutter Cathedral Hill Hospital. Bottom: the lower chart shows construction cost inflation over the period of the 2008 Global Financial Crisis. Despite this, predicted cost continued to fall. (Graphic: after Mossman et al 2010)

3.2. Value definition - sustainability, buildability, usability, functionality, maintainability

One of the key characteristics of IPD is the way value is defined from the perspective of five key stakeholders/customers:

- The **client's need** and business case (the business or economic need for the project)
- The **end-users** of the asset
- The **builders** of the asset
- The **maintainers** of the asset
- The environmental impact of the asset on the **planet**

In S.5 and Appendix 1, these and other key characteristics of IPD are further discussed to help define why IPD is different. The people that will build, use, and maintain the asset are fully involved from the *Validation* phase at the start of design. This helps the designers produce a design that meets the client's needs and is buildable, usable and sustainable while minimising whole life cost. Functionality must always meet the client's business needs.

As well as the incentive to manage cost effectively provided by the incentive pool (see 7.6) *Target Value Delivery* (TVD, formerly known as *Target Value Design*, see 7.15) uses Key Performance Indicators in Key Result Areas to incentivise performance in other delivery areas.

The UN's 2030 *Sustainable Development Goals* require the alignment of project economic and social goals with those for environmental impact. A recent paper by Margarete Olender and Anja Rosen (2023) explores how TVD can be adapted to improve the sustainability of design. They suggest that monetising environmental targets such as a price for CO₂ emissions will help focus designers on sustainable design.

We do not have directly comparable environmental benchmark figures like the cost and programme data in 3.1 but there are good examples of projects delivered for known IPD clients such as Packard, Sutter & United Health Services (UHS), (that also delivered on time and on budget or better) where key environmental goals were met or exceeded. For a typical case study see <https://www.packard.org/wp-content/uploads/2013/10/Sustainability-in-Practice-Case-Study.pdf>

3.3. Tales of two contrasting projects

In March 2023, an NH study tour visited several live IPD projects in Finland including a hospital, tramway, and a major road project. In each case the study tour members heard presentations in their “Big Room” collaboration centres followed by open Q&A sessions.

On the Turku Bridge highway project, the group met client, constructors and designers. The designers explained how they had refined the design in collaboration with the constructors (Tiers 1 and 2). This saved the €180m project €12m. See Figure 3.

FTIA created the TVD environment that allowed that to happen.



Figure 3: Before (grey) and after (green) images from the project BIM of the new Turku Bridge design that resulted in a €12m saving. (source: aki.kopra@kreate.fi ²)

In 2022, as part of the TIES Living Lab benchmarking project, sub-contractors and main contractors on NH Project X were observed at work and interviewed. The researchers identified £30m of potential savings with £2m already realised. The biggest opportunity for savings was £15m of drainage that could have been saved (but was not) because the specialist sub-contractor was not fully involved in the design.

In project X NH failed to involve all key construction specialists in design.

3.4. Limitations

Experience to date with IPD is mostly with *vertical* construction projects – buildings. There are a small number of *linear* infrastructure projects (e.g. from the Finland Transport Infrastructure Agency (FTIA)) that suggest that IPD principles and practices do successfully map across to infrastructure projects. Australian experience on infrastructure projects with “*project alliancing*” (based on a relational contract like IPD but without lean) is further evidence that these practices will transfer successfully to infrastructure.

3.5. Conclusion

IPD significantly outperforms other procurement strategies. Relational contracts like those used in IPD and Project Alliances are not for the faint hearted and take considerable effort to achieve. Others in the public sector are succeeding with IPD, so there is a path to follow.

There are well documented examples of public sector organisations new to IPD successfully delivering pilot projects in Israel (Korb et al 2016) and Norway (Aslesen 2018). Even when they

² In an email to one of the authors Aki noted that in Finland an Open BIM is used. “There is a conference hosted annually either in Lyon, France or Tampere, Finland. <https://www.ril.fi/en/events/infrabim-open-2023.html> InfraBIMOpen conference was originally founded in Finland. There you will find discussion how the open BIM approach is actually an issue to be solved by the community — not by Bentley, Trimble, Autodesk etc..”

failed to achieve some aspects or characteristics of IPD, the pilot projects in each case were highly successful. The Finnish Transport Infrastructure Agency (FTIA) have been successful with IPD with a 100% on-budget and on-time track record. There are several pilot projects in Germany that are reported making similar progress.

NH are already committed to IPD but has so far failed to realise the benefits. If it is to be successful NH needs to address several issues particularly those outlined in Table 1.

Those are discussed in more detail in the next section.

4. Where are NH now on the path to IPD?

Designers and constructors are not integrated so, despite the procurement models of SMA and RDP, there is not one NH IPD project.

Interviewee

If NH are to make a success of adopting IPD as an approach to project delivery it will need to make several changes to its internal processes, structures and culture as well as to the way it procures construction in future.

The purpose of this section is to discuss what we found in NH.

The next section (5) will show with comparisons to NH practice what needs to change.

Quantifying where NH are on the path to IPD is difficult. Our opinion is summarised in Figure 4: NH Progress Toward IPD.

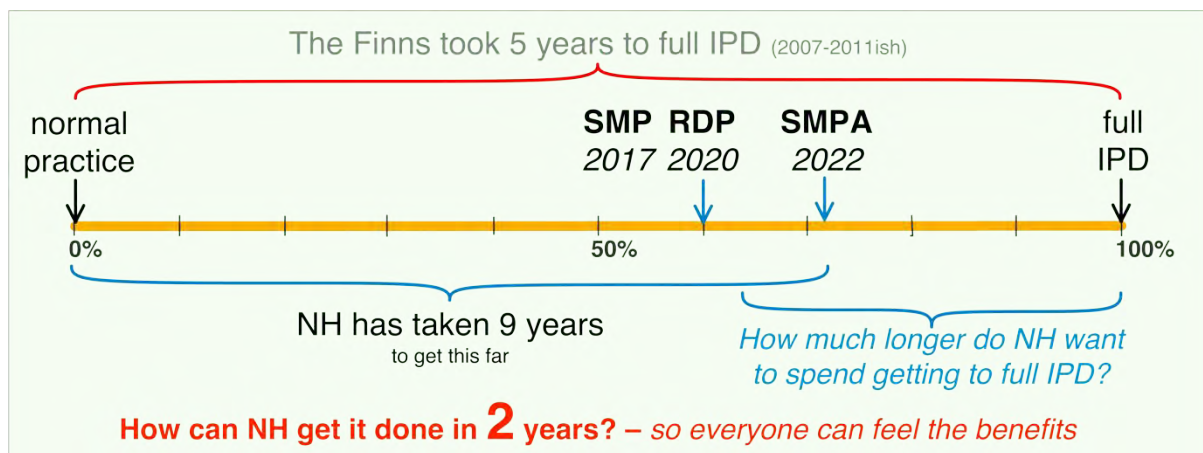


Figure 4: NH Progress Toward IPD

We arrived at this conclusion by interviewing 19 NH and Delivery Partner staff (listed in the Acknowledgements) from three areas:

- Regional Development Programme 2 projects
- Smart Motorway Programme Alliance projects
- NH support service functions such as SES, commercial and procurement.

SMP Alliance is more collaborative than previous frameworks but NH may not realise the full benefits because of recent government policy changes.

4.1. What's good about what NH has done

NH has taken the following actions:

- Collaborative frameworks such as RDP and SMPA.
- Focus on construction productivity improvement.
- Requiring auditable evidence that the supply chain is serious about lean deployment and culture.
- The direct employment of a competent internal Lean Team.
- The implementation and contractual requirement for HELMA (although not assessing itself).

- Continuous focus on best practice and innovation – such as *Innovation ReApplied* – with diverse focus groups actively working on strategic issues.
- Identifying standard repeatable elements that can be used on a variety of projects and creating standard designs and kits of parts for these.
- Commissioning this study
- Engaged in the Study Action Team reading of “Integrating Project Delivery” Fischer et al 2017)
- Supporting the Study Tour in Finland

In addition, NH are actively engaging current and future delivery partners to shape and improve the forthcoming Integrated Delivery Framework.

The intent of both RDP and SMP Alliance procurement models is to operate as IPD and include processes to better integrate design and delivery, yet designers and constructors are not integrated so, despite the procurement models, there is not one NH IPD project.

4.2. Conclusion

Based on previous good work, NH is in a good position to progress to full IPD and realise the benefits this will bring. To succeed it must begin by looking internally.

5. What must NH do to progress?

As noted in the introduction, IPD represents the current state of the art in terms of project safety, delivery, cost and environmental performance for high-complexity high-value projects. IPD is a continually evolving form that NH aspire to use to deliver better outcomes for its projects. In the rest of this chapter we will discuss what we found in NH, compare to IPD best practice and identify what needs to change to fully implement IPD.

We have paid particular attention to the role of the client in project delivery as this is the starting point for IPD.

The goal of IPD is to create a collaborative team environment where team members benefit from driving cost out whilst maintaining the agreed outcomes/goals related to safety, sustainability, quality, scope, and programme requirements. This drives value up.

You don't need IPD for simple, straightforward projects. It's excellent for projects that are complex and risky.

To make this work NH must learn to:

- **Accept risk** and manage it collaboratively with delivery partners.
- **Build trust** with and between its delivery partners.
- **Create behaviour change** both internally and externally within its delivery partners.

The key changes required are in the areas of:

- **System and structural alignment** – Section 5.1
- **Contracts and contract management** – Section 5.2
- **Leadership, culture building and management** – Section 5.3

5.1. System and structural alignment

“NH focus on what Delivery Partners are doing rather than getting their own house in order and leading the change.” Interviewee

Using systems thinking across NH

“Someone needs to tell NH we are supposed to collaborate.” interviewee

It is not only projects where collaborative working is required. NH need collaboration across its directorates and divisions. We heard evidence from NH staff, as well as from delivery partner staff, that some people from within NH are not aligned to project outcomes and commitments and do not collaborate effectively to support delivery of project objectives.

Several examples were found within NH where individual directorate priorities are at odds with successful project outcomes. NH divisions are sometimes in conflict with each other and, at times, frustrate delivery teams and erode trust with partners. This is particularly true for SES, where asset quality is prioritised, and for Commercial and Procurement where cost and contract compliance is prioritised.

Despite attempts at collaborative frameworks, an inflexible PCF process sits independently outside these and dictates behaviours.

PCF in NH

pre-project phase

0 Strategy, shaping and prioritisation **planning and strategy**

options phase

1 Option identification **major projects**

2 Option selection

design development phase

3 Preliminary design

4 Statutory procedures and powers permitting, planning permission & compulsory purchase complete

5 Construction preparation – tender
detail design, production system design

construction phase

6 Construct, commission, handover

7 Closeout

source: Highways England 2022

- *There is rarely continuity of design responsibility through the process. People may change over time – why change the responsible design house?*
- *New design houses generally dump previous design work – is this so they can bill more hours?*
- *How do we shift design house focus from billable hours to satisfying client requirements?*
- *“Constructors come on board very late in the process so their cost inputs are not considered until late in the design – and sometimes not until after design is substantially complete”* interviewee
- *“Stage gates are important – do they need to be so bureaucratic? ... so detailed?”* interviewee
- *Will PCF be necessary when IPD is being used and client system is able to see project process so clearly?*
- *DfT start date KPI gets ~50% of projects started too early and adds cost. Key date is completion date.*
- *“They still hadn’t achieved SGAR 5 but were halfway through the job”.* interviewee
- *Where is the focus on value for the client.*

Figure 5: The Project Control Framework PCF - a critique. PCF is being reviewed. These are issues that need considering.

Another way of thinking about alignment is in terms of NH as a system.

Systems need to be managed ... for resilience – the ability to recover from perturbation, the ability to restore or repair themselves.

Donella, H, Meadows. 2008. *Thinking in systems*.

There were clear signs in the interviews that NH doesn’t think of itself as one system. “A system is an interconnected set of elements that is coherently organised in a way that achieves something” (Meadows 2008). NH is a system for providing and maintaining safe strategic roads in England within the investment committed by the Government.

Sometimes the elements of a system – which can themselves be a system – seek to achieve things that undermine the purpose of the system of which they are a part. For example, among other things, SES has an important responsibility for safety in the NH system. To be able to do this the SES team must be integrated into, and act as an integrated part of both NH and individual project delivery teams. To do this, with limited resource across multiple schemes simultaneously requires close attention to detail in planning at a portfolio level. The function for this portfolio planning does not fall to any one delivery partner, but rather sits as a necessity in Major Project Delivery Services. The failure to do this integrated portfolio management means that NH support elements are disrupting the flow of work on projects and, in the process, disrupting NH outputs. Uncoordinated support from internal teams is seen by interviewees as a consistent NH system failure.

In a system that is working well, elements are *aligned to purpose* and the whole system performance is improved. Instead of working solely to a departmental/divisional agenda each element looks at its neighbours as internal customers that exist in a wider NH system designed to fulfil a known and clear purpose.

R1. Conduct an internal “Systems Review” to build alignment.

The Management Factory

Hierarchical systems evolved from the bottom up. The purpose of the upper layers of the hierarchy is to serve the purposes of the lower layers.
Donella, H Meadows. 2008 Thinking in systems.

The outputs from *management factories* are activities initiated by managers that sit above operations, above where real value is created. Effort goes into serving management and creates no value for the customer. These activities are justified as they make the life of leaders and managers easier. Managers do this because they want to know what is going on at the workplace, but not to go and see for themselves **and** they have lost sight of their purpose – to enable, support and improve value creation. Often those policies and reporting requirements make the work of those who must follow them more difficult. This frequently affects the value creators. Many get team members '*keeping management informed*', writing reports, developing strategy, making proposals to improve worker engagement even though none of the activities create value for customers nor enable value to be created.

In effective organisations, management sees their role as serving and supporting those on the front line who are delivering to the customer. Reducing the number of managers and having fewer layers between the top and the bottom helps.

Interviewees talked about the reporting requirements in the PCF process (currently under review) and in the CPF. Measuring doesn't change anything, yet many in NH seem to act as if it does — believing that more measuring, more monitoring, more KPIs, more tendering leads to better value for the tax-payers' pound. In fact, the opposite is true.

Metrics

“Core stuff, such as risk, cost & programme management, isn't working as it should.”
interviewee

Inevitably in any large organisation, agendas emerge that seek to optimise the performance of individuals, departments or directorates. This often works against the overall aim of the system. As well as being customers of the NH system, DfT and ORR are part of the system. DfT set KPIs for project operations. The Investment agreement sets commitments to enable the investor to have an expectation of benefits from the investment. Some of these KPIs are, probably unintentionally, undermining work that NH and its delivery partners do. Good systems thinking would have predicted the unintended negative consequences of introducing a new KPI.

One particularly unhelpful KPI originates in DfT. Interviewees reported significant financial losses driven by starting projects before they were ready, before SGAR 5 was passed. Ultimately these losses are a cost to taxpayers. One person reported “more than 50% of projects start early”. The critical date is when the project is complete.

Setting arbitrary targets can cause perverse behaviour. Arbitrary targets are set without the involvement of the people who must deliver them and are often not based on facts; so the people who must deliver them don't understand why they exist (Deming 1985, 70-77). There is no trust. There are lots of examples of arbitrary targets causing perverse behaviour in both the public and private sectors — teachers working to manipulate SAT scores; police manipulating

arrest and other records; people in the NHS focusing on meeting targets rather than on keeping people healthy. People fudge figures or processes to make it appear that the target has been met or as Seddon (2000) wrote *“their use in a hierarchical system engages peoples’ ingenuity in managing the numbers instead of improving their methods. Peoples’ attention turns to being seen to meet the targets – fulfilling the bureaucratic requirements of reporting that which they have become ‘accountable’ for – at the expense of achieving the organisation’s purpose. ... Targets are capricious. While they are assumed to provide a spur to improvement, they actually make performance worse.”* It is important that project teams fully understand why each target exists, what the Conditions of Satisfaction are, who will assess the results and how they will do that. Building that understanding is one of the functions of the *Validation* process used in IPD at the start of the project.

Measures, KPIs and KRAs are designed to build collaboration rather than create internal competition. Creating an effective system is “management’s job” according to Deming (1985, 117-8; 1994, 125-8).

In successful IPD projects there are very few KPIs. They are there because they produce beneficial behaviour on the project. Using too many KPIs as secondary targets can confuse delivery team members and undermine group cohesion. We suggest there should be no more than five KPIs in total.

NH should conduct an internal review of all KPIs and KRAs to ensure they support desired behaviour within NH and within NH projects. This will require:

- examination of individual departmental drivers/agendas to identify those that conflict with the overall aim of the total system.
- a review of departmental KRAs and KPIs to ensure they benefit the end-to-end system.

R2. Review the use of all KPIs and KRAs to ensure they support desired behaviour.

Data integration → a single source of truth

“With 13 DIPs, how do you expect them to agree a common data environment. Without it, there is no single version of the truth.”

Interviewee

Interviewees complained that technology systems were not aligned across the supply chain which leads to waste and frustration.

Projects lack a single version of truth in scheduling, cost, and design. NH has said it wants to have a common data environment, a single version of the truth. It has not created or procured one and has not required its delivery partners to agree one. This means that there are several versions of the digital project design at any one time. This creates digital rework and is a major obstacle to getting an agreed, collaborative design. This in turn makes it difficult to prepare coordinated and agreed cost estimates – and an agreed and integrated schedule against which to plan either the work or making work ready.

Data on a common platform will eliminate redundancy, make clash avoidance easier and make the operational management and use of data much easier.

Successful IPD clients insist on integrated technology and data creating “one source of truth”.

NH need to consider standardisation of technology requirements within future procurement. Colleagues in Finland are working to develop an open-source platform with colleagues in Japan, France, Norway, Sweden, Denmark, and Estonia. See: <https://www.ril.fi/en/events/infrabim-open-2023/contact-committees.html>

R3. Lead development of a common data platform and require delivery partners to use it.

5.2. Contracts and contract management

NH uses NEC bilateral and transactional contracts. The NEC suite are more relational than most transactional contracts. On the RDP Framework there was no requirement for delivery partners to have back-to-back contracts with their supply chains and when this omission was realised there was no action to remedy that. Fortunately it is now a requirement on the SMP Alliance.

Koskela, Howell and Lichtig (2006) argue that the new production thinking implicit in TVD and IPD needs a new contract that refers to an ongoing relation rather than to an independent event. They point out how “the idealization errors of both the transformation and the transaction concept ... generically cause counterproductive results”.

Experienced IPD clients in the private sector and some in the public sector use a multi-tier, multi-party IPD relational contract that fully engages specialist designers and constructors who can affect the success or otherwise of a project. Nothing in UK law prevents NH from following suit.

Make it easier for NH central functions to work effectively with IPD delivery teams.

If NH wants fast delivery from the delivery team that it chooses, NH itself needs to be fit and agile so that it does not slow project delivery. As Davies, Gann and Douglas 2009 showed from their experience on the Heathrow Terminal 5 (T5) project alliance, successful project delivery requires a high level of system integration. Drawing on their experience of T5, they proposed a conceptual framework for managing mega-projects shown in figure 6 below.

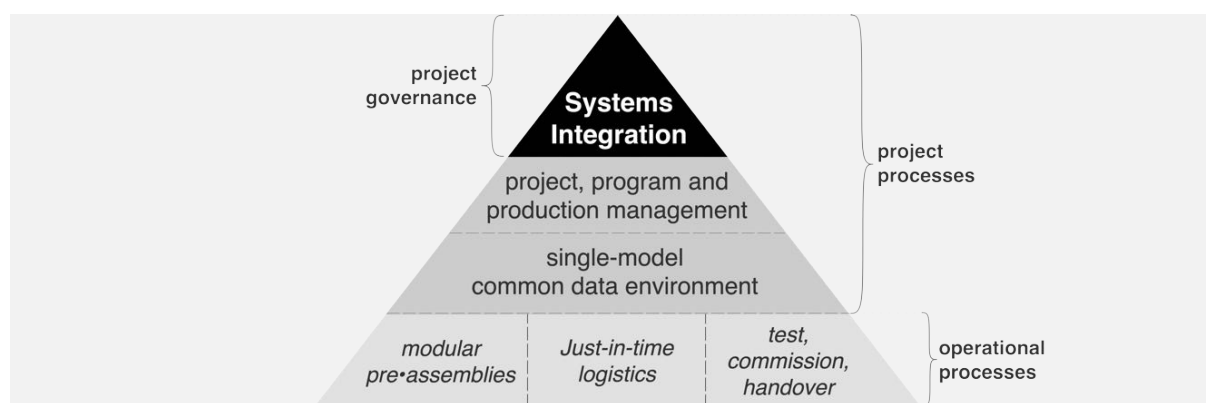


Figure 6: mega-project management model

While many NH projects do not reach Davies, Gann and Douglas’s threshold for a mega-project (>US\$1.4bn (£1.1bn) at today’s prices) the principles remain useful.

The model is built around six processes required to execute a mega-project:

- **Systems integration** to coordinate the design, engineering, integration, and delivery of a fully functioning operational system;
- **Project and program management** to support an integrated supply chain (*to which we suggest production management is added*);

- **Digital design technologies** to support, design, construction, integration, and maintenance activities;
- **Offsite fabrication, pre-assembly and modular production** to improve productivity, predictability, quality and health and safety;
- **Just-in-time logistics**, to coordinate the supply of materials, to increase speed and efficiency;
- **Operational integration** to undertake systems tests, trials and preparation for handover to operations.

These processes form a system of production that is coordinated and controlled by systems integrators³. NH have chosen to outsource systems integration responsibility to lead constructor delivery partners. It appears that not all integrators fully understand what NH expect or requires.

In *Team of Teams* McChrystal (2015) describes how Al Qaeda in Iraq (AQI) initially ran rings around the truly hierarchical US and allied forces. AQI dominance continued until allied forces adopted a similarly agile and networked organisation. There are many parallels between this and project delivery.

With its origins as part of central government, NH is still a bureaucratic and hierarchical organisation. The current contract forms create proto-networked organisations for each project. IPD will create even better networked organisations that can run rings around NH if it remains so hierarchical.

R4. Ensure that Delivery Partners' lead systems integrators fully understand and work effectively with NH expectations and requirements.

Legacy projects

Switching from an existing contract to IPD will not work. IPD needs to start at the beginning of the project so that the designers and constructors are both involved with the client in the *Validation* process and in setting the budget, agreeing a handful of Key Result Areas (KRAs), Performance Indicators and the project governance system.

To support full TVD NH must *Left-Shift* to involve those that will build, operate and maintain, (main contractors and tier 2s) fully in design (see p.32 Get all the team involved early and 7.15 TVD). That is only possible at the start of PCF stages 1, 3 and 5.

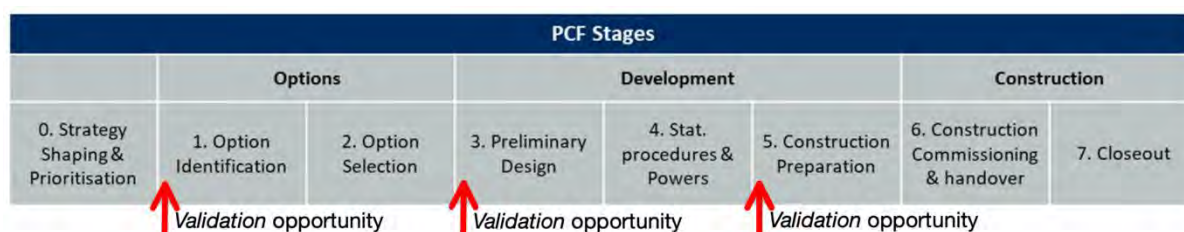


Figure 7: NH PCF Validation opportunities for starting both TVD and IPD

R5. Allow projects that have started to complete using their existing agreements and contracts.

³ *System integration* is how an organisation brings together components, subsystems, software, skills, knowledge, engineers, managers and technicians to produce a product (Hobday, Davies and Prencipe 2005).

We are advised that the SMP Alliance already allows this flexibility.

Frameworks and project delivery timelines

NH procure new frameworks every five years or so. This pulse does not align with all project delivery timelines. We were told that, in the past, projects starting later in one framework are shifted to the new framework – and the new contractual arrangements – part way through the project. This has created problems in these legacy projects.

Two schemes, Birtley to Coalhouse (RDP2) and the M6 Smart Motorway J21 are “legacy” projects, meaning they started before the advent of the current framework contracts. It may be the case, in fact it probably is the case, that “the die was cast” on these projects before the implementation of the new forms of procurement.

Switching existing projects to IPD will only work at the start of current PCF stages 1, 3 and 5. Whenever a team start with a project using IPD they should be allowed to continue to completion so long as the parties work within the spirit of the IPD agreement and TVD process.

R6. Make future NH frameworks flexible so that suitable individual projects within a framework can be delivered using IPD.

NH procure with frameworks; NH can procure IPD in that context

Over the last few years NH have been procuring delivery partners in each region through frameworks. IPD is primarily a single project procurement strategy, although it can be procured through a framework alliance.

What can NH do? Ashcraft writes (in Mosey 2019, Ch 25):

Several firms that use IPD consistently have developed “master IPD agreements”, designed to fulfil the same functions as a framework alliance contract. In one case, approximately 85 firms have signed a single master IPD agreement that contains the legal terms applicable to all, including how costs are calculated and paid. The terms of the agreement were jointly negotiated by all parties in three web conferences. The master IPD agreement does not authorise or guarantee any specific work. Projects are implemented by issuing a project authorisation, signed by a subset of those signing the master IPD agreement. The project authorisation specifies the commercial terms, scope and modifications necessary to accommodate local legal requirements.

Other firms have developed standard IPD agreements that they pre-negotiated with their principal designers, builders and suppliers. In this approach, a draft IPD agreement is circulated for comment and the comments are then correlated and negotiated in a series of joint meetings or web conferences. Based on the comments and negotiations, a final IPD agreement is created that addresses consistent concerns. Comments or concerns that are only raised by a single organisation are generally not incorporated into the final agreement.

Design + pain/gainshare

"This was the first time they have done something like this. RDP has good intent, but we didn't set off on the right foot with it. Designers actually worked the way they always do. "Bums on seats" design behaviour"

Interviewee

"With a client hat on, you want to have control. PCF doesn't help control cost in the design stage. It puts the focus on getting bits of paper signed off"

Interviewee

"Traditionally, contractors are paid based entirely on cost – that is, the contractors estimate how much it will cost them to procure the labour and materials, add a mark-up for overhead and profit, and present a lump sum or guaranteed maximum price to the [client] or upper-tier contractor. This results in a chain of contracts that flow back to the [client], but do not interconnect project participants across contractual lines. As a result, each contractor operates under commercial terms that provide economic incentive for it to maximize its own project outcomes regardless of whether its actions would hurt other project participants or benefit the project as a whole. This approach further provides little or no incentive for non-cost performance (Darrington 2010)." "Research in economics and psychology ... shows that intrinsic motivation interacts in complicated ways with economic incentives. Thus, the challenge of designing incentives is to harness the selfish motivations of all agents while preserving the intrinsic motivations that most agents possess (Darrington and Howell 2011)".

It is important to link incentives to simple objectives that people can hold in their head, understand the value of and understand how they will be measured.

The intent of the primary incentivisation arrangements (the profit pool in Figure 24) on an IPD project are to bring the project in at or below the target cost. KPIs are used to incentivise other behaviours. The primary incentive is large (all profit and corporate overhead is at risk)

The intent of both RDP and SMP Alliance is to create integrated project operations including integrating design and delivery. How they work is not understood and not generally used. Some examples were given where this is succeeding but overall there appears to be a need for NH to improve how it functions in this space. We were assured that both RDP and SMP Alliance enable delivery partners to create incentive pools for the whole delivery framework community yet this is not normal commercial behaviour, has not been done and NH have not tried to lead the creation of incentive pools.

RDP adopts a lump sum arrangement to govern the development phase (Figure 8), and a target cost arrangement during the construction phase (NH RDP Delivery Integration Partnership Framework, Volume 0, Instructions for Tenderers 23.04.18 p.67, B.1.4). Within the PCF process *Validation*, as the starting point for Target Value Design, is useful at the start of stages 1, 3 and 5. It is not clear why:

- NH chose to only begin using Target cost at the beginning of stage 6 when the design is substantially complete.
- NH only apply Target Cost incentive to Delivery Integration Partner(s).

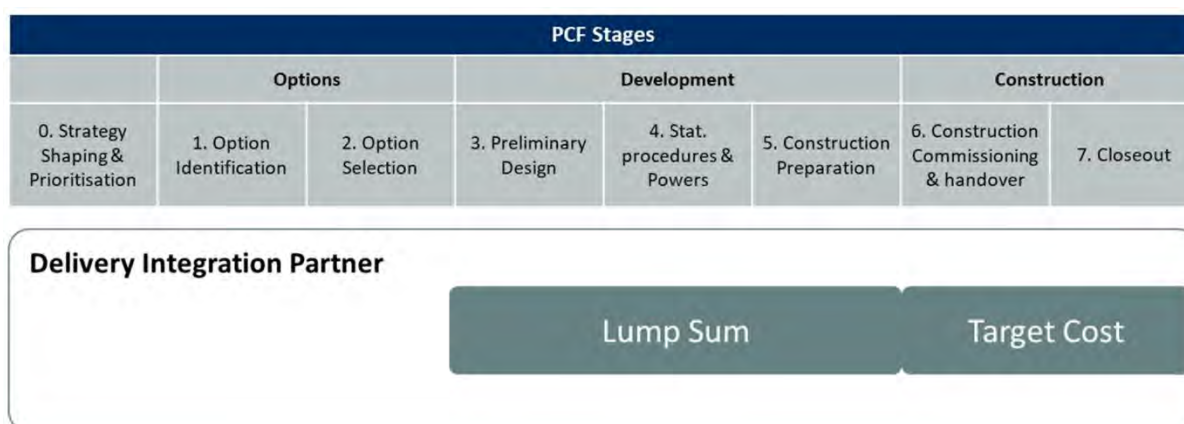


Figure 8: from RDP DIP Framework Instructions for Tenderers 23.04.18

B.1.5 states “The Delivery Integration Partner ... can offset pain incurred on one Scheme ... against gain achieved on another.” If NH adopted full IPD, delivery partners are able to do this too. Pay-outs from each scheme pool are made at the end of each scheme (and, if agreed, part payments at risk made during the scheme).

B.1.6 envisages “The Budget for a Scheme is to be agreed by the end of PCF stage 3.” It is not clear why NH chose to work in this way unless it assumed that the cost could only be established once the Preliminary design was complete (design then cost) rather than proceeding using TVD and conceptual estimating in the Validation phase before design commences. Working in the way NH proposes is an incentive to the delivery partners to inflate costs during Stage 3.

We are still not clear how the SMP Alliance incentivisation works despite several attempts to clarify the process for us. This level of complexity is of itself a concern.

Following Hall and Bonanomi (2021) both the target cost and incentive pools are “shared resources”. Both create a pluralistic organisational setting and encourage consensus, mutual understanding and align decisions and actions. “Shared decision-making rights can reduce uncertainty and de-risk projects, but”, they note, “without proper governance structures they can increase the risk of inaction among pluralistic stakeholders.” IPD extends this plurality throughout the entire project life cycle – validation, design, construction and commissioning.

In IPD the client typically manages incentivisation to create some or all of these benefits:

- improved design quality and continuity.
- Improved project environmental performance
- reduced design changes & re-design once on site.
- improved collaboration throughout the project.
- improved visibility of how their collaboration is contributing to the incentive pool.
- improved adoption of appropriate lean processes in the design stage.
- encourages designers to abandon the “*Target Utilisation of Designers*” metric (paid time) as other delivery partners challenge its use.
- allows delivery partners to be rewarded at the end of the project.

NH must decide whether it is most advantageous to NH to:

- incentivise projects in the IPD way (project-by-project with a shared profit pool incentivising project cost compliance + KPIs for other client criteria) **or**
- incentivise collaboration at the framework level and use KPIs to secure cost, time and other criteria on individual schemes.

This is a complex decision and an ideal application for **Choosing By Advantages**.

Clarity on the above will simplify many other decisions and provide clarity to individuals in project and programme leadership roles.

R7. Decide what is the most advantageous incentivisation system for NH project and framework outcomes.

Figure 9 shows what Bob Mitsch, Vice President for Facility & Property Services at Sutter Health, believes is important in a good IPD business deal. In making that assessment he was able to draw on 12 years' experience in the role.



Figure 9: Getting the Business Deal Right (Mitsch 2016) SH = Sutter Health.

Managing culture

“Existing culture is hiding true cost info”

Interviewee

“NH doesn’t role model the desired behaviours that are inherent in collaborative contracts”.

Interviewee

“There appears to be a belief in NH that Value is created by doing more governance.”

Interviewee

As indicated elsewhere in this report, a prime role of an IPD client is to create and maintain a collaborative culture. Collaboration between SMP Alliance Tier 1s is reportedly excellent; elsewhere there is still a lot of work needed. It was clear that on many projects an IPD culture is non-existent. One interviewee described their project culture as “toxic”. There is a gap in the role of the client on these projects where the client team is creating a transactional culture not an integrated culture by the individual actions of its representatives.

Some projects are already expecting maximum pain despite the fact that they were not involved in a formal *Validation* process. This leads delivery partners to behave in a precautionary, defensive way and makes it easy for them to conclude that the client is not interested in the team meeting the Target Cost or is unconcerned if it constrains the Integrated Project Team (IPT) from achieving it.

There have been efforts by NH to improve the culture, for example by the implementation of the Improving Behaviours Improving Performance (IBIP) profiling tool. IBIP only focuses on one aspect of IPD. The required culture will only emerge when all key IPD elements are managed – including the contract form, lean processes (that must include TVD and Big Room), integrated IT systems and desired behaviours. This requires NH to actively lead projects with skilled and experienced Integrated Project Leaders (IPLs – See 7.20 IPLs: The client’s representative on an IPD project).

R8. Adopt full IPD contracts when using IPD on projects with NH.

NH might want to consider negotiating changes to the SMP Alliance so that, among other things, it:

- supports full IPD
- fully integrates and incentivises Tier 2s & 3s
- makes clear that *Target Utilisation* of staff (see p. 30) is inappropriate.

Validation – Target Value Delivery

The current NEAR programme target budget of £390m for 150 Emergency Areas was arrived at and set by the client using designers with some constructor consultation (but no “skin in the game”). Subsequently different designers and constructors were selected to deliver the project and expected to accept the budget set by others.

Under IPD + Target Value Delivery, it is essential that the integrated project team is fully engaged in the validation process to agree whether or not the project can be delivered within the budget. It is the client’s role in IPD to create the space (culture, processes, etc) for co-creating the solution and mitigation of process constraints. This differentiates IPD from other delivery methods.

Successful IPD Clients invest significant effort working in collaboration with those that will actually design and build to understand and set realistic budgetary and other goals. The key governance process undertaken before committing funds is called Validation. This means that all key stakeholders involved in project delivery agree the budget collaboratively before design begins.

They then focus on using a minimal set of KPIs that are designed to influence correct shared risk and co-creation behaviours.

R9. Ensure the designers and constructors responsible for project delivery are involved in *Validation* within the Target Value Delivery process for each project.

For more on *Validation* in the Target Value Delivery process see 7.11.

We are concerned that there appears to be insufficient understanding of what both IPD and TVD are. It feels like NH has yet to fully understand both the problem and the opportunity, so are unsure of how to proceed.

Interviews revealed that despite a procurement process and contract that already allows TVD and the associated high levels of engagement, collaboration, and early involvement, this isn't being done. Traditional "entrenched" behaviours remain. Even integrators are not taking the opportunity to work together with the design teams to make the work in the construction phase easier, let alone involving constructors in the process.

R10. Ensure any member of a project delivery team that can significantly affect the outcome of a project is engaged at the outset as a full delivery partner

Designers and constructors are not integrated so, despite the procurement models of SMP Alliance and RDP, there is not yet one NH full IPD project.

Face-to-face collocation (R17) will support team integration and so should be considered for inclusion in future contracts.

Ensure that there is a clear *and agreed* **dispute resolution process** built into future contract/agreement (R18) and encourage senior leaders to resist attempts to escalate disputes to their level when the contractual process has not been exhausted.

5.3. Leadership, culture building and culture management

"The success of IPD is disproportionately linked to the capability of the Project Manager and NH has a very mixed batch." interviewee

Successful IPD requires direct leadership. Initially this should come from the client. Once the culture and direction of the project are clear it may be appropriate for leaders from the designer and/or the constructor to guide the project through particular phases.

Interviewees said that project leadership in NH varies from "inspirational" to "average". Several were concerned that delivery partners poach "the good ones".

As described in more detail in 7.20, successful delivery of IPD projects requires specific skills and ways of thinking. The prime functions of an IPD leader (IPL) are to:

- Establish and maintain a culture of intense collaboration.
- Facilitate fast, effective, and transparent decision-making.

NH expects delivery partners to work collaboratively but neither NH nor the delivery partners appear to understand how to coordinate, integrate, incentivise and lead collaboration.

As can be seen in Appendix 1 — IPD is complex

"A key IPD leadership responsibility is to ensure that the right people are talking about the right things at the right time in the right way." Senior Sutter client representative talking to Bob Mitsch.

The collaborative intent of RDP and SMP Alliance is yet to be fully realised. This may be because there is:

- a lack of understanding of what it means to collaborate at **all** levels including NH own staff, Tier 1 delivery partners, designers, and key tier 2 contractors and designers.
- a lack of tangible incentive such as is provided by the incentive pool in IPD
- absence of leadership to guide the process from both NH and from Integrators

One of the ‘peculiarities’ of construction projects is they are delivered by temporary organisations. We assemble teams to deliver projects and expect them to perform. If the team don’t understand the required culture or possess the right skillsets, results are ‘sub-optimal’.

The education and experience of most people in the construction sector is built on what happens in projects that use bilateral, transactional, and adversarial contracts. In that environment it is difficult to trust.

In successful IPD projects in Finland, we observed significant effort on the part of the client to ensure that the people that work on the project understood the required IPD culture and core skills. They went as far as to make prospective bidders sit an exam to test their understanding as part of the procurement process. Later they required more senior managers to pass an exam before starting work on the project as part of the *on-boarding* process (p.39)

The client role in IPD is fundamentally different from the client role in other transactional procurement systems. It sets and enables the cultural and other changes that lead to significant improvements in performance. It uses equality, diversity, and inclusion of the Integrated Project Team to create more than the sum of the parts. It focuses on enabling frontline value creators to improve their processes with the support of everyone else on the project.

Why? All the evidence shows that client leadership is essential to help delivery teams make the transition from historic transactional ways of working to an integrated collaborative way, integral to IPD. This evidence also shows that projects fail when the client rep doesn’t hold fast to the IPD vision, contract, or manage the boundaries. This is more likely when the client rep is not adequately supported by the client organisation.

Figure 10 is from an LCI USA webinar in 2016. What it shows is the value to the client of getting involved early in project. Engaging early improves outcomes. With IPD, early client engagement is essential.

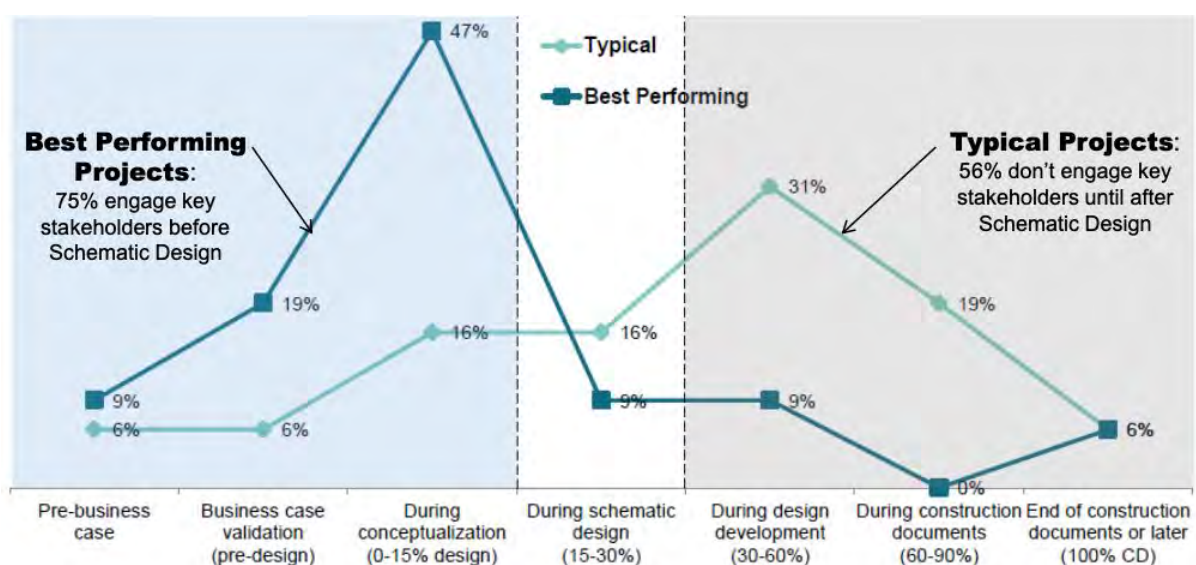


Figure 10: Timing of Key Stakeholder Engagement: Early engagement is key aspect of best projects (source: Mace and Laquidara-Carr 2016)

The client representatives role is to create and maintain a collaborative culture and an environment appropriate for collaborating; facilitate the Core Team as equal members; keep everyone working to the client's objectives; facilitate effective decision making; provide overall project leadership; ensure that agreed project processes are being used; make sure the delivery team are working effectively to the IPD contract; build and maintain a single integrated data environment on a common data platform/BIM.

Table 3 (after Knapp et al 2014) summarises key differences between IPD and normal transactional projects.

Table 3: comparison of IPD and transactional project delivery practices

IPD	normal transactional
Leadership facilitates collaborative direction	Leadership dictates direction
Planning is collaborative, project-based and seeks to integrate efforts to eliminate negative iterations. The IPD organization learns as the project evolves.	Planning is partitioned by trades and disciplines and is linear. It is predictive and generally fixed, setting parameters for management
Management develops a “network of commitments” to implement the plan. Processes and measures are integrated, proactive and designed to improve team performance.	Management controls are inflexible, autocratic – processes are fixed and measures are isolated and generally historical

Key client skills: In addition to an understanding of construction, construction finance, construction risk and construction planning, senior IPD project leaders need good leadership, facilitation, Choosing By Advantages (CBA), Target Value Delivery (TVD), Lean, Visual Management (VM), Collaborative Planning, Last Planner System⁴ (LPS), Big-Room, emotional intelligence, psychological safety, team dynamics, team building, stakeholder engagement, organisational politics, dispute resolution, culture building, production management and control skills and the personal resilience to manage and maintain boundaries, standards and principles when necessary. More information on the skills and knowledge that leaders in IPD need in is in 7.20.

Develop leaders across the project

Tjell and Bosch-Sijtsema's study (2015) of three integrated and partially collocated building design teams showed that the physical presence of the client in an integrated design team:

- helps client understanding of the design teamwork processes and challenges
- positively affects the relationship between the client and the team as the client becomes visible to them.

Traditionally the client is absent from the design team and makes demands. Physical presence alone is not enough. Engagement is fundamental to this new way of working. As this role is not yet well defined, it's important that the client understands that their role is changing to be active in the design space, sharing their needs and wishes with the team and contributing to the decision-making.

⁴ In the past Highways Agency was reluctant to use Last Planner because of the registered trade mark ® associated with it. Lean Construction Institute in the USA owns the trade mark and is happy for construction organisations to use it. The trademark exists to protect organisations like NH from unscrupulous consultants. Using The Last Planner System will enable NH to connect with advances in thinking about LPS. Every other company that used IPD openly talks about LPS.

Client participation in the design process is only one part of the Client IPD Project Manager role (IPL on p. 69).

R11. Develop from within and retain (or recruit and retain) suitable IPD project managers.

Facilitate the Core Team within IPD project governance structure

“The SMP Alliance contract is not easy. It is the most complex contract I have ever worked on.”
Interviewee

As indicated earlier, a prime role of an IPD client is to create and maintain a collaborative culture. Collaboration between SMP Alliance Tier 1s is reportedly excellent; elsewhere there is still a lot of work needed. It was clear that on some projects no IPD culture exists – and one interviewee described their project culture as “toxic”. Some client representatives are allowing a transactional culture to emerge instead of leading the creation of an integrated culture on their projects.

The required culture will only emerge through a combination of applying the key IPD elements including the contract form, lean processes (that must include TVD and Big Room), and integrated IT systems. This requires NH to actively lead the projects with skilled and experienced integrated lean Project Managers.

Adapt leadership and management styles to each phase

Each phase within a project has its own purpose and needs a different management focus. The boundaries within the phases are not always clear so it is incumbent on the IPLs to make the transition clear and to change the way they manage people so that it aligns with the purpose of the current phase.

Projects are systems – the purpose of major projects within NH is to enhance the existing network to address capacity constraints. Project systems can be frustrated by the actions of divisions within NH and the actions of individual delivery partners.

Originally instigated in the 1980’s by an ambition to control design cost, the focus of current design house business models is on maximising billable hours. *Target Utilisation* creates a conflict of interest with the client’s objective of delivering customer value within target cost.

In an IPD project that is working well, elements are *aligned to purpose* and the whole system performance is improved. Instead of working to a ‘home office’ agenda each delivery partner looks at its neighbours as internal customers that exist in a wider system that is designed to fulfil a known and clear purpose.

In the early days of IPD deployment in NH, it may be difficult for one delivery partner to confront another on issues like this. It is clearly in NH’s interest that this kind of behaviour is dealt with and the NH project leader is the ideal person to do that in the context of the project core team.

R12. NH to take responsibility for facilitating Project Core Teams using IPD.

The interviewees were clear that attempts to move closer to an IPD model are hampered by a general lack of understanding of IPD. Comments such as “This was the first time we have done something like this” and “nobody understood what they signed up for” were frequent.

To help NH take an active role in project delivery, it needs to both develop and retain skilled integrated project leaders (IPL) who will lead NH projects. The IPL role is complex and demanding. If NH is successful at developing IPLs it will lose them to other organisations unless it has a suitable reward package for them. While the skills may have been developed in a roads/infrastructure environment, most of them are transferable to many other project-based production contexts.

R13. Invest in helping NH staff and chosen delivery partners learn IPD.

Develop an IPD training package to include:

- IPD Awareness – everyone involved. Focus on culture & behaviours.
- IPD Leadership
- IPD tools & techniques to include:
 - Adopting the full *Last Planner System* — current NH “*Collaborative Planning*” is only part of the full system
 - Choosing By Advantages
 - A3 Report (Design/problem solving/decision reporting) – (not only KTPs)
 - Scrum / Cluster Teams in Design
 - Big Room
 - Visual management.
 - TVD

Consider the learning from the Finnish Study Tour. They require key individuals (not companies) working on the project pass an IPD exam.

Lead Target Value Design & Delivery (TVD) (see 7.15)

“Designers are on a lump sum contract, not in pain gain sub-contract to main contractors; commercial risk is with main contractors”

Interviewee

“Construction getting pushed back due to late design and lack of urgency in design management”

Interviewee

“3 months extra in design might save 6 months on site.” (in the context of DfT too early start issue)

Interviewee

One of the intentions behind current procurement frameworks was to encourage early involvement of constructors in co-creating the design, Collaborative Planning and pricing to under-shoot the project target cost. Target costing, one of the key components of Target Value Delivery (TVD), requires the client, designers, and constructors, to work together at the design table. This has only been happening in a very limited way. Delivery teams do not understand TVD and, lacking appropriate knowledge and understanding, many NH staff have not helped delivery teams to learn by doing in a TVD way.

Some projects are already maxed out on pain, which has led to suppliers reverting to precautionary defensive behaviours generally associated with transactional contracts. This is not surprising, particularly if they were not involved in an initial cost Validation exercise, but inherited work done by others.

Our interviews, as well as conversations held on the study tour, suggest that designers' focus remains on maximising utilised time, rather than collaborating to meet the project objectives and verifying the design to be within budget and Target Cost. This is a widespread and significant issue and opportunity. NH currently suffer from *Target Designer Utilisation* and are not benefitting from Target Value Design.

This reinforces our concern that there appears to be insufficient understanding of what both IPD and TVD are. It feels like NH has yet to fully understand both the problem and the opportunity, so are unsure of how to proceed. As a result of this lack of understanding, the value of significant incentives (7.6) is not given sufficient attention.

Interviews revealed that despite a procurement process and contract that already allows high levels of engagement, collaboration and early involvement, this isn't being done. Traditional "entrenched" behaviours remain. Even integrators are not taking the opportunity to work together with the design team to make the work in the construction phase easier, let alone involving "tier 2" partners in the process.

Design and construction are not integrated nor are tier 2 suppliers, as they would be in an IPD project.

R14. Insist on and lead Target Value Design and Delivery.

Figure 11 shows how the current NH PCF system maps onto the TVD system and illustrates why it will help NH to rationalise PCF for future projects.

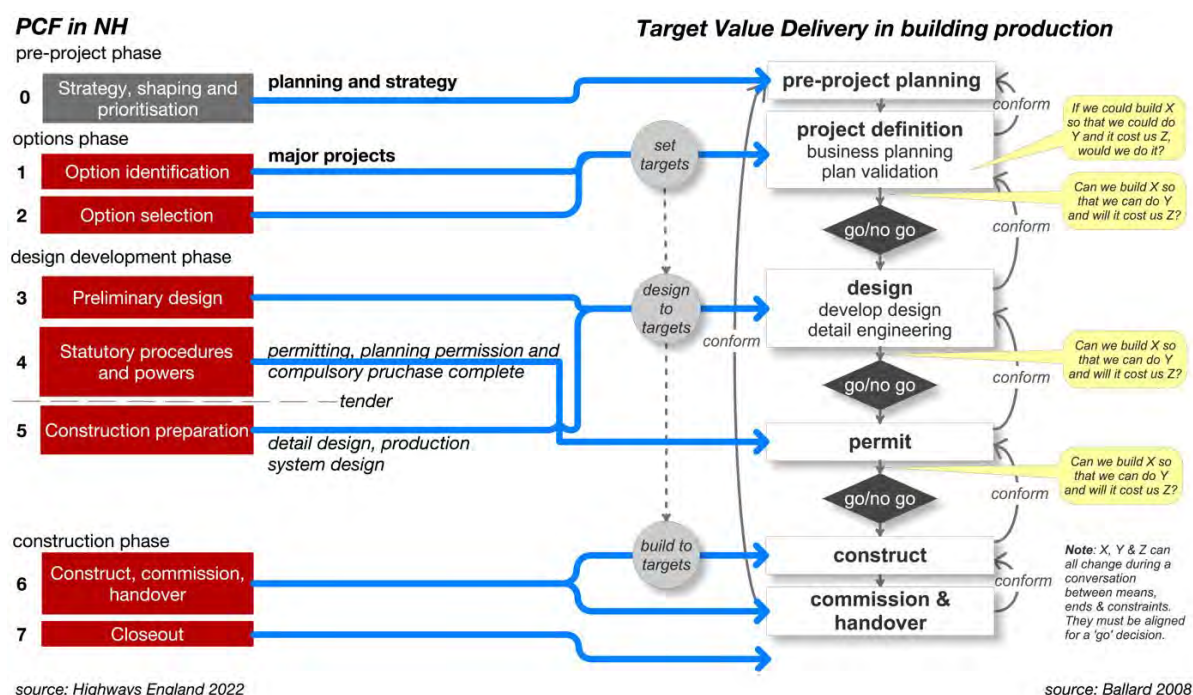


Figure 11: Simple Mapping of NH PCF system to IPD/TVD

Get all the team involved early

Left-Shift refers to the idea of getting the organisations that will construct the work, including *critical path* deliverers on board much earlier so that costs come from those with ‘skin in the game’ and methods of working, innovation in technique, and ideas, advice, and experience are baked into the design. This is essential for IPD and TVD – both require the constructors costing skills so that designers can design with a regularly updated predicted cost for the project. As

Figure 12 shows there are also advantages to *left-shifting* the design effort, so that more people who will deliver the project are involved in decisions made early in the process when the cost of changes is low and the ability to make changes it's much easier.

An added benefit of *left-shifting* is that constructors can design the production process/method for the project alongside the design of the product and adjustments to the product design that make the design easier to build are made early in the process when changes are cheaper to make. It also means that preparation planning involves everyone, and the constructor can confirm what they need to make work ready for production. This avoids second guessing by intermediaries and streamlines the make ready process. Constraints to making tasks ready within the system are spotted early and mitigation co-created by the delivery team.

Using TVD helps teams to design to the project objectives, and to improve the project.

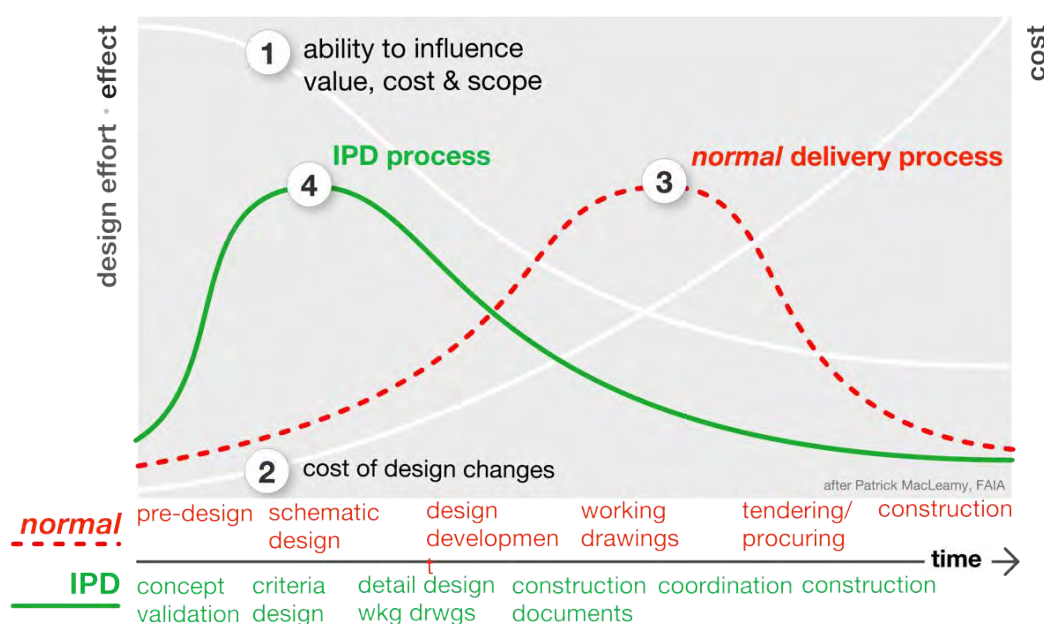


Figure 12: Integrated & 'normal' design processes – the "MacLeamy Curves" (after CURT 2004)

R15. Require all delivery partners to contribute their fee (= overhead + profit) to an incentive pool that is at risk if the project team overspend.

For more on how that works see Figure 24.

Provide and insist on big rooms/collocation

"Collocation was clearly beneficial – but it ended up in the "too hard" box".
Interviewee

Since COVID-19 and the parallel transformation of technology, it has become the new normal for organisations to offer employees the flexibility to work remotely so now there is resistance and reluctance to co-locate, despite the proven benefits to IPD.

A recent article in *The Economist* ("The working-from-home illusion fades", 28Jun23) reported that stories suggesting remote working from home was more productive than in the office have not stood up to scrutiny. This is supported by a randomised control trial by MIT researchers Atkin, Schoar and Shinde (2023). They found the **productivity of workers chosen to work in an office was 18% higher** than those chosen to work at home. This is equivalent to a free day of extra capacity every working week. There is more about this in 7.13.

One of the practical steps that successful IPD clients take to establish and manage culture is to get everyone working face-to-face in a *Big Room*.

When colocated, it is much easier for the client, as integrator, to guide and lead work to project objectives. Particularly in the early phases of a project, some degree of co-location is vital to build the team and the required culture.

R16. Create client led collocation/collaboration hubs.

IPD is a new way of working. Clients and their delivery partners need to learn this new way of working and we believe that co-location is the fastest way of doing this. Two thirds of the productivity gain mentioned above (Atkin, Schoar and Shinde 2023), was visible from day one and the rest is attributable to office-based workers learning faster. This data seems to present a strong argument for insisting on at least same-day pulsed collocation for all staff on a given project.

Audit attendance and make this a requirement.

R17. Insist on face-to-face co-location.

For more on the importance of collocation see 7.13

Dispute resolution

In the Study Action Team, and on the study tour, we heard stories about disputes being quickly escalated to members of the NH executive and other senior leaders rather than going through the organised team dispute resolution process. This takes up the executive's time unnecessarily. It is not clear why executives accept the disputes, rather than asking the person who is lobbying them if they have exhausted the existing dispute resolution process.

In Finland, when asked about escalation, the client view was that people in the management group of IPD should be selected for their ability to release potential by resolving issues effectively. A choice to unilaterally escalate would be met with a challenge that maybe they were not right for the IPD management team and required replacement. Coupled with this was a consistent and routine use of transparent and organised decision-making techniques. By using Choosing By Advantages and communicating decisions using a centralised and accessible register of A3 decision reports, disputes were less frequent and more quickly resolved.

Within IPD, there is a quick dispute resolution process designed to find an amicable resolution. The parties in dispute have a very organised time frame to find a resolution before the dispute moves up a level.

Sutter provide a 2% project contingency which is used by the delivery partners to solve problems (Mitsch 2016, 13:00). Disputes are one kind of problem. Among other things this protects the client from some issues.

R18. Use more structures, organised, and transparent decision-making techniques and systems to reduce opportunities for dispute.

Make tough decisions when it is important to the team's success

"You cannot legislate goodness"

Dr. Martin Luther King, Jr.

Bryson (2010, 127-8) says *"this is the biggest leadership challenge for [a client]. ... being tough for the team means that the [client] stands up in a caring and thoughtful manner to defend an*

important principle that is imperative to the team's success." Sometimes the client needs to be tough within the team, for example, when it's not functioning properly and at other times, the client needs to put energy into defending the team. Even the best teams make mistakes. The client needs to be willing to get critics off the team's back.

"Bad behaviour from a team member should be addressed quickly and decisively for the sake of team culture. Any unaddressed problem will cost the team time, money, and some measure of success" (Bryson 2010, 128). In his presentation Bob Mitsch (2016 at 11:00) attributed early Sutter failures to poor decisions in the selection of partners and reported that if key participants do not fully subscribe to the collaboration/shared risk model, they will self-optimize. *"If potential partners do not share your values and ethics, **the contract will not save you**"* (Figure 13).

The slide has a teal header with the title "Secret Sauce – The Right Partners". Below the header, the quote "You cannot legislate goodness" is displayed, followed by the attribution "~ Dr. Martin Luther King, Jr.". A bulleted list contains three points: "Early Sutter failures were due in part to poor decisions in the selection of partners", "If the key participants do not fully subscribe to the collaboration/shared risk model, they will self-optimize", and "If potential partners do not share your values and ethics, the contract will not save you". At the bottom left is the Sutter Health logo with the tagline "We Plus You". A small number "9" is in the bottom right corner.

Figure 13: Selecting the right partners; deselecting the wrong ones (Mitsch 2016).

The contract alone will not save NH and NH must be willing to be tough to get projects back on track.

Several clients leading IPD projects have terminated delivery partners for paying lip-service to IPD principles, practices and processes as well as client's ethics and values. When the client actively manages boundaries it sends a clear message to the whole supply chain about what is, and is not, acceptable and reinforces the client's commitment to the new way of working.

On both the Women's and Children's Hospital in Sacramento and in the Mills-Peninsula Medical Center project in Millbrae, CA, Sutter terminated the lead constructor following clear warnings. It was the same company in both cases, one of the largest contractors in the US. This action helped that company subsequently 'get' lean as well as signalling to the Northern California construction market that Sutter was deeply serious about its commitment to procuring on a lean basis.

In Florida, Jackson Health, a public-sector healthcare organisation, terminated a national architect and a national constructor on one \$110m project. The national architecture firm wouldn't change out their lead designer who wanted to do a signature project. With the project \$50m over budget, the lead constructor wanted to take the project back to the old way of delivering. Bill Seed said *"I had to show them I was still the project manager."* He went on to note *"If you push people too far outside the box, it becomes counter-productive."* Seed is clear that he would be willing to work with the constructor in future but not the designer.

In the NH NEAR programme one party, however well informed and supported, imposed its will on another and created a transactional culture while, at the same time seeking to convince the community of its intention to be collaborative under an IPD contract. NH did not take the tough

decision to challenge the first party and if they failed to get back in line remove them from the project. Without that kind of leadership, other delivery partners may end up feeling that its OK to behave in the transactional way they always have.

The need for tough decisions, tough choices can become clear in many ways. Relationship or process breakdown; audit reviews; open book; feelings of distrust for example. On most US IPD projects anyone at any level in a project organisation can “declare a breakdown” and call a meeting to resolve the issue. Unresolved issues or when a pattern of breakdowns emerges may be signals that tough decisions are required from the client individually or working in concert with the Core Team of the project (see Figure 23).

R19. NH must be willing to support tough decisions when they are important for project success.

Facilitate working transparently

Both constructors and designers have hidden profit centres. They can be in preliminaries, overhead, labour rates, retaining savings from increased productivity. Adversarial contracts assume that no party can be trusted. On IPD projects the expectation is that everyone will trust the other parties and verify that that trust is appropriate.

If, in the budget, 2,000 hours is included for a particular activity and you know it has been delivered in 1,600 hours you would expect to see some money returned to the project contingency. IPD requires delivery partners to work on an open book basis and each party is entitled to examine the books of every other party. The client must take the lead on this on behalf of taxpayers – it is their money that is being retained or returned.

Client led audit of a project is part of the process of building and maintaining trust with and between the delivery partners and an important part of governance (7.5).

Using Choosing By Advantages (CBA) for making decisions through consensus ensures that all the stakeholders understand the reasons why decisions are the way they are (documenting CBA decisions means that if information on which a decision is made changes it is easy to review the decision and decide if it needs to be changed).

All delivery partners need to be involved in these processes.

R20. Trust and verify delivery partners – and encourage them to do the same.

Serve and support the value creators on the project with servant leadership

Lean thinking defines value, support activity and waste from the point of view of the customer. Value to customers happens when something changes in line with what they want. So if a design is progressed or a concrete pour takes place correctly, value is created. Other things that must be done to enable these tasks are known as support activity and anything else is waste.

The Value Creators are the people that personally execute the work – this is what customers want to pay for and typically happens at the coalface. Managers either support this or conduct or cause wasteful activities.

Successful IPD Clients have learnt to get their delivery teams to focus on the needs of those who do the real work, the Value Creators, understanding that their role is primarily to support these as shown in Figure 14.

NH will get better value for the taxpayer if it changes this focus in the way shown in Figure 14. The value creators are the most important people on a project.

R21. Shift the focus of NH to supporting value creators.

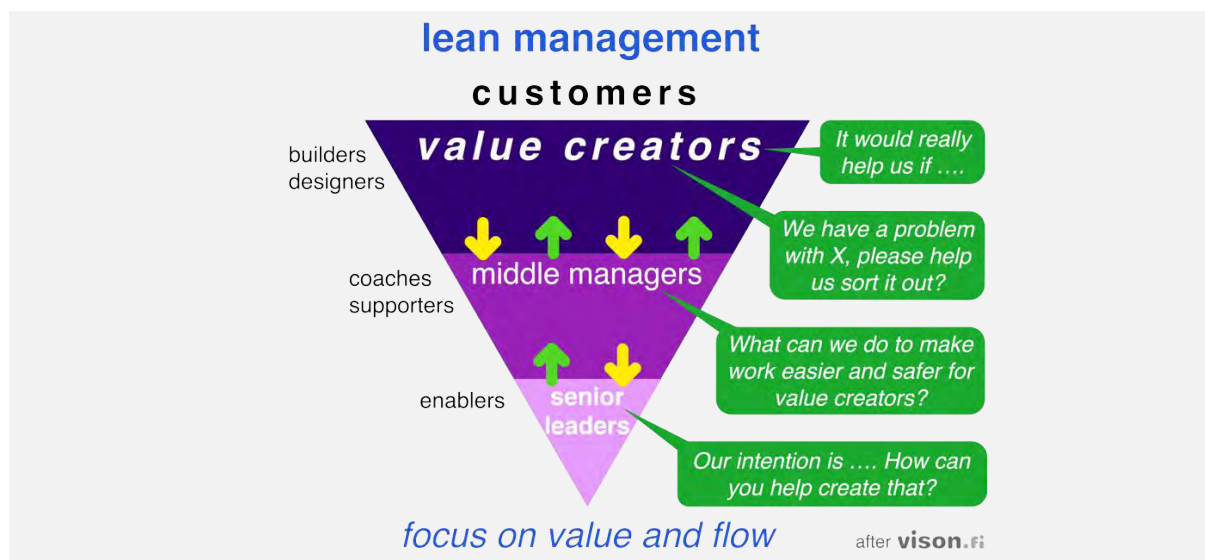


Figure 14: Value Creators create what the customer wants. The role of everyone else is to make it easier for the value creators to do their work.

Part of the role of NH Integrated Project Leaders (IPL) should be to work with delivery partners to identify and remove impediments to value creators delivering quality work. This will be to everyone's advantage as the safer, faster and cheaper the value creators are able to deliver quality work the quicker NH will get the value they want while the delivery partners costs will fall as illustrated in Figure 15.

Figure 15 is the critical part of Dr WE Deming's Quality Chain Reaction (1985, 3). Deming shows that the only way to systematically reduce costs and to improve productivity is to improve quality. Attempts to reduce cost without improving quality generally end up adding cost as well as reducing productivity. Similarly efforts to improve productivity without first considering quality are likely to increase costs as they generally involve significant expenditure.

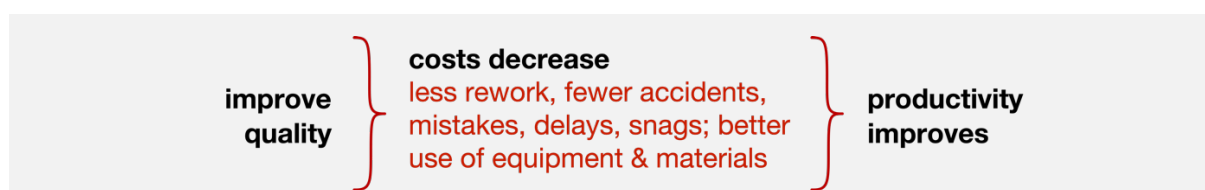


Figure 15: Part of Deming's Quality Chain Reaction

Getting delivery partners working together on this will help things move more quickly as it is much easier to see 'old habits' from outside the system under review.

Create psychological safety across NH, projects, packages and frameworks.

Value creators need to feel safe if they are to fully engage in the way shown in Figure 14. It is important that everyone, not just the value creators, feels able to speak up. Most people won't speak up if they don't feel safe to do so. Harvard Professor, Amy Edmondson, has written an excellent book on psychological safety. If, as the client, NH want to get honest, straightforward information from individuals and teams among the delivery partners, it needs to ensure that all

individuals, including the value creators, feel safe enough to share their concerns, ideas and insights.

Ryan and Oestreich (1998, 107-126) describe the many ways that fear costs organisations and projects dearly. When people are afraid they become unwilling, or unable, to raise issues they face. The issues become undiscussable. Fear engenders frustration, anger, bitterness, cynicism, resentment that can lead to:

- Political and self-protective behaviour.
- Revenge and sabotage.
- A reluctance to put in extra effort.
- People thinking about and changing jobs.
- Making and hiding mistakes.
- Poor problem-solving.
- Working on the wrong priorities.
- Using poor methods.
- Low levels of creativity and risk taking
- People feeling bad about themselves and/or about their work situation

As Flores (2016, 25) notes, the moods of fear, confusion, resignation, frustration, anxiety, distrust, resentment are all moods that get in the way of learning.

In a psychologically safe setting nothing is undiscussable. It needs to be created in each project and within the teams delivering elements of each project. The people and the organisations are different on each project and client leadership working together with the Core Team can build an appropriate, safe project culture.

R22. Create psychological safety across each project

Psychological safety will enable value creators and others to call out the nonsenses of the management factory (see The Management Factory p.18).

Define decisions and facilitate decision-making with relevant stakeholders using CBA

Being clear about the decisions that need to be made, getting agreement to the importance of the decision and the definition of that decision are important leadership tasks and particularly important for client representatives and IPLs. Once the required decision is clear and agreed, the next step is facilitating the decision making in a transparent and consensual way with all relevant stakeholders.

Widely used on IPD projects in the US, as well as on the NH Lower Thames Crossing project, the CBA decision-making system includes a variety of decision-making tools and methods that are unified by just one set of definitions, models, and principles.

Making good and effective decisions will have a profound impact on any project.

R23. Use CBA on all projects

Foster a learning culture and manage moods on the project

“the complex nature of design and construction projects, and the sheer scale of the knowledge that it takes to accomplish them, make it imperative that players in the process are cooperative and focused on common success.”

Bryson 2010, 129

There is lots to learn for everyone involved in complex construction projects. There is even more to learn when a new way of working is introduced. When Sutter Health embarked on its lean journey in 2004 it set up what became the first Lean Construction Community of Practice (CoP). The CoP brought together people from Sutter and its delivery partners with academics, consultants and anyone else who wanted to show up. The usual structure was a presentation by a group about an improvement they were working on, followed by discussion over dinner, then listing the key points and questions that led to Q&A and discussion. Delivery partners readily shared their ideas, learning and practices.

Sutter, and the facilitators they worked with, created an environment that made it much easier for people and teams to learn – encouraging the moods of wonder, curiosity, ambition, confidence, trust, resolution. (Flores 2016, 29).

In contrast the moods of fear, confusion, resignation, frustration, anxiety, distrust, resentment get in the way of learning (Flores 2016, 25). Helping individuals and teams make a transition from moods that get in the way to the moods that are conducive to learning is an important skill for managers at every level. It is particularly important for IPLs and members of the project core team as they manage the overall project.

These efforts are supported by an effective incentive pool, psychological safety (so that individuals feel free to share their concerns) and transparency.

R24. Foster a learning culture and manage moods on the project

On-board individuals and teams throughout the project

Individuals and teams join and leave a project throughout its life. It is important that new members understand the way IPD works and the way the project they are joining is managed and that they are aligned to the project goals and values as quickly as possible.

Most people joining a project will have spent most of the working life in working on “normal” projects, using “normal” ways of thinking. The IPD way is different.

Successful IPD Projects have a well-planned regular on-boarding process that all new members are expected to engage in before they start working on the project. In Finland, we heard that new members are only allowed to start working on the project if they have passed an on-boarding exam!

The messages communicated in the on-boarding process will need to be continually reinforced once people are working on the project. Without an on-boarding process, the risk is that team members behave in the “normal” transactional way on the project and destroy the collaborative environment that has been so hard worked for.

R25. On-board individuals and teams throughout the life of each project

Reinforce the on-boarding messages in the project process.

5.4. Other considerations

In his 2016 presentation Mitsch explained that in 2004 Sutter were struggling with IPD – we had no tools, no strategy, no partners who understood and we didn't understand. Mitsch and his colleagues at Sutter worked with their delivery partners and academic and consulting partners to build a shared understanding, to create the tools and design the strategy that enabled them to make IPD work.

In a presentation to IGLC31 in Lille (June 2023) Neal Symmons (NH), Barbara Pedo (Arcadis) and Prof Lauri Koskela (University of Huddersfield) all talked about the benefits to NH, one of its delivery partners and the academic community of a collaboration around a Knowledge Transfer Partnership (KTP).

Further KTPs and actively working with the academic community and Communities of Practice (see Foster a learning culture and manage moods on the project on p. 39) may help NH to do something similar around the adoption of IPD.

As you will see from Appendix 1: What is IPD? there are many other features of successful IPD that are not covered here. In this section we have attempted to present the most pressing issues to allow significant progress to be made.

6. Conclusion

IPD is complex and requires client commitment to work. The Client must invest in aligning its own organisation and processes, educating itself and its chosen delivery partners. This is what successful IPD clients do.

A relatively recent development in contracting, IPD delivers extraordinary performance in high value and high complexity projects. There is now too much data available to consider this success could only be by chance (see Figure 1: Percentage of projects on time and on budget or better). NH clearly aspire to IPD performance and have invested significant effort to get there. Some progress has been made, particularly with SMP Alliance, which could more easily move even closer to full IPD.

In all successful cases known to us the efforts have to focus on Client leadership and capability as the *first priority*.

IPD is not for the faint hearted and will take considerable effort to achieve, however others have done it so there is a path to follow. The Finnish Transport Infrastructure Agency (FTIA) have been successful with IPD with a 100% on-budget and on-time record.

In our literature review we found well documented examples of organisations that were completely new to IPD. They ran pilot projects trying to emulate experienced client exponents. They failed to achieve some aspects or characteristics of IPD yet the pilot projects in each case were highly successful.

The characteristics identified in Table 2 are here linked to recommendations in this report. The purpose of the table is show how these might contribute to NH's transition to full IPD. Not all the recommendations are mentioned as not all are directly relevant to individual projects/schemes.

Most of the characteristics in Table 4 are drivers of change. Only 5 are results or manifestations of IPD. Most of the "results" appear in the section on **Leadership, culture building and culture management** and are marked with an *. The importance of culture and behaviours cannot be overstated.

Table 4: comparison of IPD and normal transactional construction linked to recommendations

R	IPD	normal transactional
	Value	
R8	To deliver a sustainable, buildable, useable, operable quality full-scope facility safely, on-time and within the client's budget.	minimise first cost with as much of the scope requested by the client as possible.
	System and structural alignment	
R3	Effective use of BIM in a common data environment that helps prevent clashes	BIM, common data environment unlikely; clash detection and rework
R8	Systematic <i>Validation</i> of client business case by delivery partners and client together	Receipt of written brief
R8	Last Planner System (LPS) of Production Control - generally with Takt in building construction	Unreliable Critical Path schedules
	Contracts and contract management	
R6, R8, R10	A single multi-party contract - client, designers, tiers 1 and 2 with shared profit pain/gain. Whole team contractually bound to a common goal	Many bi-lateral, transactional contracts

R	IPD	<i>normal transactional</i>
	Suppliers procured mainly on level of expertise/capability	Suppliers procured based primarily on cost
R8	Creates a temporary organisation focused on delivering what the client wants; parties behave as if they were one company	Creates a temporary organisation in which each party seeks to avoid failure, risk and claims and maximise their own interests
R8	Profit and cost are separated	Profit is a proportion of cost
R8, R15	Incentive pool rewards are shared across all signatories; delivery partners stand or fall together (win-win)	Each member of the supply chain is out to maximise their own profit.
R2	Jointly developed and validated meaningful metrics that reflect client value; some may add to the incentive pool	Uncertain or no shared metrics
R8	Delivery partner costs are guaranteed to completion	Varies according to contract type - often no guarantees
R8	Limited entitlement to variations	Defects in design are exploited by constructors to make claims; Costs hidden
R8*	Money can move easily across boundaries (between parties)	It can't move or is very difficult to move.
R8	Risk managed collaboratively	Risk pushed down the supply chain
R8	Financial Transparency – Open Book. Parties can interrogate each other's costs	Costs are hidden
R8	No blame, no claim Liability Waivers	Parties are individually liable
Leadership, culture building and culture management		
R11	Significant client involvement particularly in early stages of project	Brief and monitor; respond to requests
R11	Client is an equal member of the delivery team	The client delegates lead role to a consultant or contractor
R14	Client defines values & goals so entire team can understand, quantify, validate & track what they are working toward	Some of the team understand.
R16 R17	Work Face-to-face in physical collocation space (Big Room)	Remote and/or infrequent F2F contact
R14	constructors actively involved in the design	Constructors procured after design is done
R14*	Production system designed alongside product design	Production system deigned after product design complete
R14	Use Target Value Design to design to cost	Design then price
R8*	High willingness to collaborate	I'll collaborate if you pay me and I won't lose anything
R20*	Mutual Respect & Trust (with verification)	Varying degrees of trust (from zero to ...)
R23	Extensive use of decision-making tools such as CBA and A3 Reports	No agreed methodology for decision making
R19	Client prepared to replace <i>Rotten Apples</i>	Make do with poor behaviours
R22	Team openly acknowledges errors and mistakes to protect the project.	Team hide problems to protect themselves
R22	Collaborative decision making as close to where the work gets done as possible	Remote decision making - often not visible
R22	Design change decisions are typically made by the team in less than 1 day	Design change decisions take several weeks

R	IPD	<i>normal transactional</i>
	Visualisation extensively used for prototyping to avoid errors	Some visualisation but allows many errors through
R24*	Rapid incremental & breakthrough improvement & learning; improvements acted upon quickly.	Limited ability to implement improvements

Should National Highways continue to pursue IPD?

We think it should, given the extraordinary performance gap that has been confirmed and the progress already made.

7. Appendix 1: What is IPD?

What if all the design and construction entities on a project, could be organized in such a way that they all functioned as if they truly were a single company with a single goal and with no competition amongst themselves for profit or recognition?"

Mathews et al (2003)

Integrated Project Delivery (IPD) is “a project delivery method that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication, and construction” (Rubel et al 2014).

While *normal* delivery methods are based on *transactional* contracts, IPD is generally based on a multi-party *relational* contract. Developed in the USA within the lean construction community, it is a holistic approach for project design and delivery⁵. It is now seen as a method with the potential to revolutionize construction performance.

Key features of IPD are listed in Table 5. The reader is encouraged to reflect on the similarities and differences with the way both *normal* construction is done and the current processes within NH.

Table 5: key features of an IPD Project.

Feature	Detail
Focus	Value for the client and end-users see 3.2 above
Commercial terms	Relational contract see first paragraph above
# parties	The client + at least the lead designer and the lead constructor; other organisations that can seriously affect the success of the project are often also joined in the relational contract. See 7.9
Client involvement	Continuous involvement of client and key designers and builders from early schematic design through project completion
Lead constructor	Lead constructors are involved from the start of the project
Operating system	Last Planner System (in all phases of the project); LPS is often associated with Takt planning
Organisation	Collaborative, though the client can cancel the contract at any point
Incentives	Team-based; aligns business interests; shared profit pool focuses team on cost; some projects reward teams for delivering KPI results linked to selected other goals such as time, scope, appearance, safety, ...; see 7.6
Principles	We all win or we all lose ... win/lose is not acceptable Start slow to go fast It is everyone's responsibility to declare breakdowns so that the breakdown can be resolved as quickly as possible.
Presuppositions	Nothing is so good it cannot be made better
Assumptions	IPD delivers projects faster and at lower cost than <i>normal</i> construction.

⁵ IPD *per se* is not designed for use in a *framework agreement* though it can be adapted for use in that context - see p.21.

Feature	Detail
Governance	The project is run by a Core Team that generally involves senior leaders from the client, the end users and from the lead designer and the lead constructor; decisions will usually be made by consensus. The Core Team report to a board made up of senior leaders from Key Delivery Partners and from the client.
Dispute resolution	There is a clear procedure for dispute resolution at each level and a rapid escalation of disputes that are not resolved quickly. The aim is to resolve disputes quickly and amicably.
Financial management	Most of the work on this is done by the Delivery Partners; it is in their interests to minimise the spend while maximising the scope; The terms of the relational agreement incentivise the Delivery Partners to work together as advocates of the project.
Open Book	Each party's books are open to every other party to the relational agreement.
Costs reimbursement	Time, materials and project overhead are reimbursed monthly in arrears;
Profit & corporate overhead	Shared <i>incentive pool</i> . Pain/gainshare agreement that can reduce or enhance the fee covering profit and corporate overhead that is 100% at risk.
Insurance	Collaborative; single insurance policy so far as possible within the law.
Blame	No fault, no blame and no sue agreement between delivery partners (with possible exception for gross and/or wilful negligence); this encourages collaboration as it reinforces the principles (above)
Location	Physical collocation for at least part of the time. See p.33 and 7.13
Design	To Target Cost using Target Value Delivery (TVD, see 7.15); costing done by constructors with Target Values in mind; contingency sums reduce as costing confidence intervals are continually reducing.
Target Cost	Draft target cost initially established by reference to market; Allowable cost used in the relational agreement agreed as part of the validation process.
Decisions	Made collaboratively, often consensually. Principle and evidence based. Choosing by Advantages (CBA) is used frequently. Decisions are made as close as possible to where the information is.
Risk	Collaborative sharing of (nearly) all project risks
Management	Collective responsibility
Key Processes	Last Planner System; Takt Planning; Promise Cycle; Target Value Design, Set-Based & Integrated Concurrent Engineering; A3 Problem Solving; A3 Reports; Choosing by Advantages; ...
Trust	Trust with verification; supported by <i>Open Book</i> . It takes a while to build trust
Process check	It is open to anyone (individual or organisation) to declare a <i>breakdown</i> in agreed process(es); this is a signal for the whole team to come together to review.
Team maintenance	Collective responsibility; overall management by the core team;
On-boarding process	Collective responsibility for on-boarding individuals, teams and organisations as they join the project
Learning	The delivery team becomes a learning organisation.

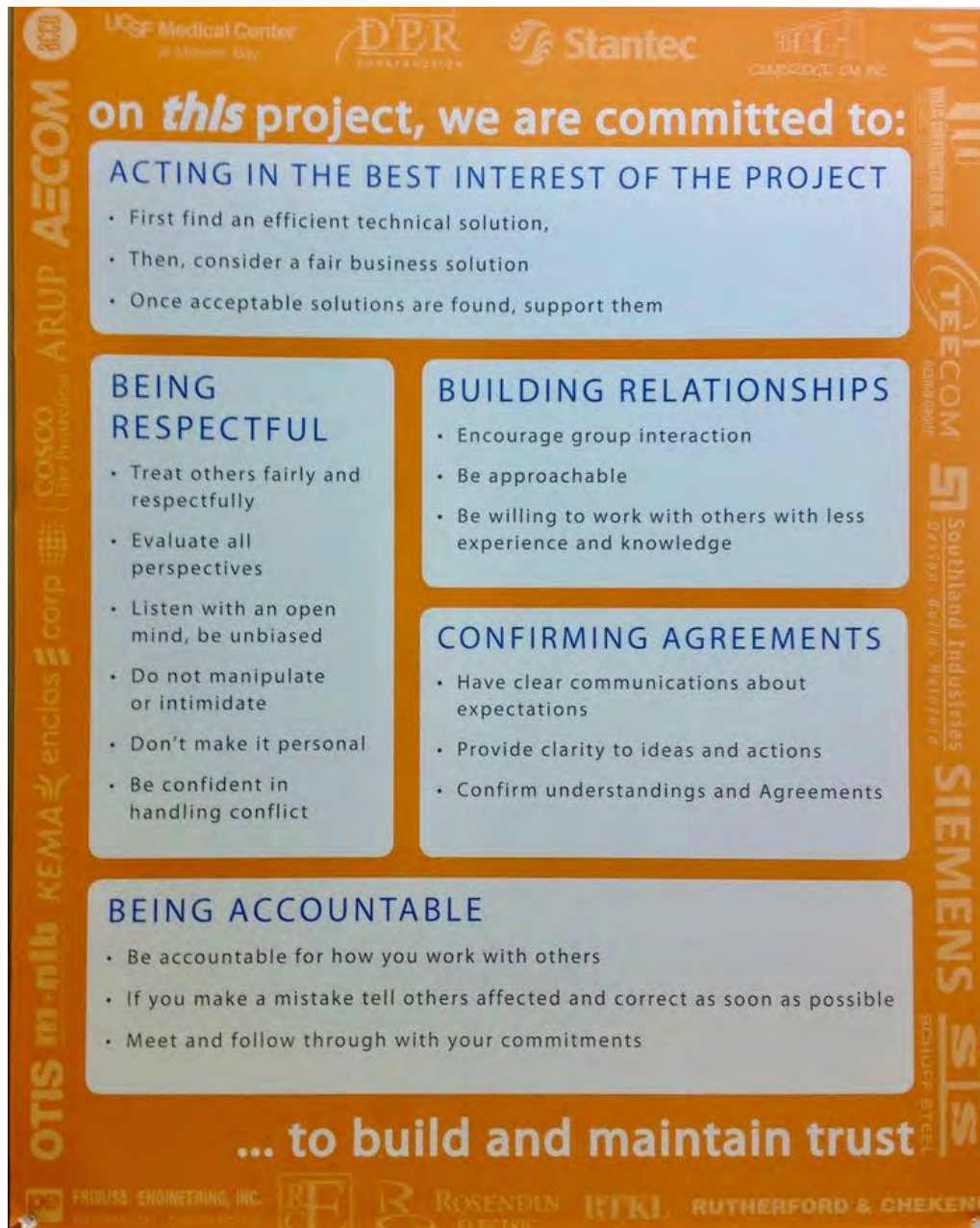


Figure 16: Poster from the big room at UCSF Mission Bay Medical Center in 2012 (photo: Mossman)

7.1. The Goal of IPD

The construction sector is fragmented and current contracts often encourage silo working and the optimisation of individual businesses rather than a focus on project success.

The goal of IPD is to create a collaborative team environment where team members **benefit from driving the cost down** whilst maintaining the agreed quality, scope, and programme requirements.

Team Members means - the client, designer, contractor, *and* specialist trades. They work together closely starting before the concept design stage.

To understand and enable IPD, it is necessary to completely rethink current construction and management practices and processes.

IPD creates an integrated high-performing *masterbuilder* team that shares “completely the responsibility for the entire project and set[s] about correcting deficiencies or problems wherever they pop up without regard to who caused the problem or who is going to pay for it.” Mathews *et al* (2003).

7.2. Tool based interventions vs a systems approach

IPD is a systemic and transformational approach to making work flow on construction projects. It is the current state of the art of lean design and construction practice.

Some organisations look at IPD projects, see the tools being used and think that they can do IPD by just using the tools. Tool-based interventions of that sort yield superficial results.

IPD, like lean itself, is an emergent process – one that is continually being improved. Target Value Delivery, explained in detail in section 7.15, is central to the IPD process.

7.3. What is involved in IPD?

Different organizations approach IPD differently. There are, however, consistent similarities to be found within most IPD projects — see next section. At the core, an integrated team jointly develops project targets, makes decisions by mutual consensus and shares the risks and rewards for achieving them (Azhar *et al.*, 2014).



Figure 17: Sutter's five big ideas (developed by Hal Macomber, Lean Project Consulting)

David Chambers, former Director Architecture, Planning and Design at Sutter Health, has summarised these five key ideas (Figure 17) for IPD teams to focus on:

- Insist on real collaboration among all of the key participants from beginning to end
- Focus on increasing the capacity of those participants to interact effectively with one another
- Construct the work as a “network of commitments” among participants, rather than as the traditional list of tasks
- Make the job of optimising the project as a whole explicit and guard against the tendency to optimise the parts with little regard to the impact on the whole
- Treat the entire project as one in which everyone involved will have important learning to do at various moments along the way and couple all of the action with that learning. (Chambers 2011, 19)

Figure 18 illustrates key differences between normal and integrated approaches to construction.

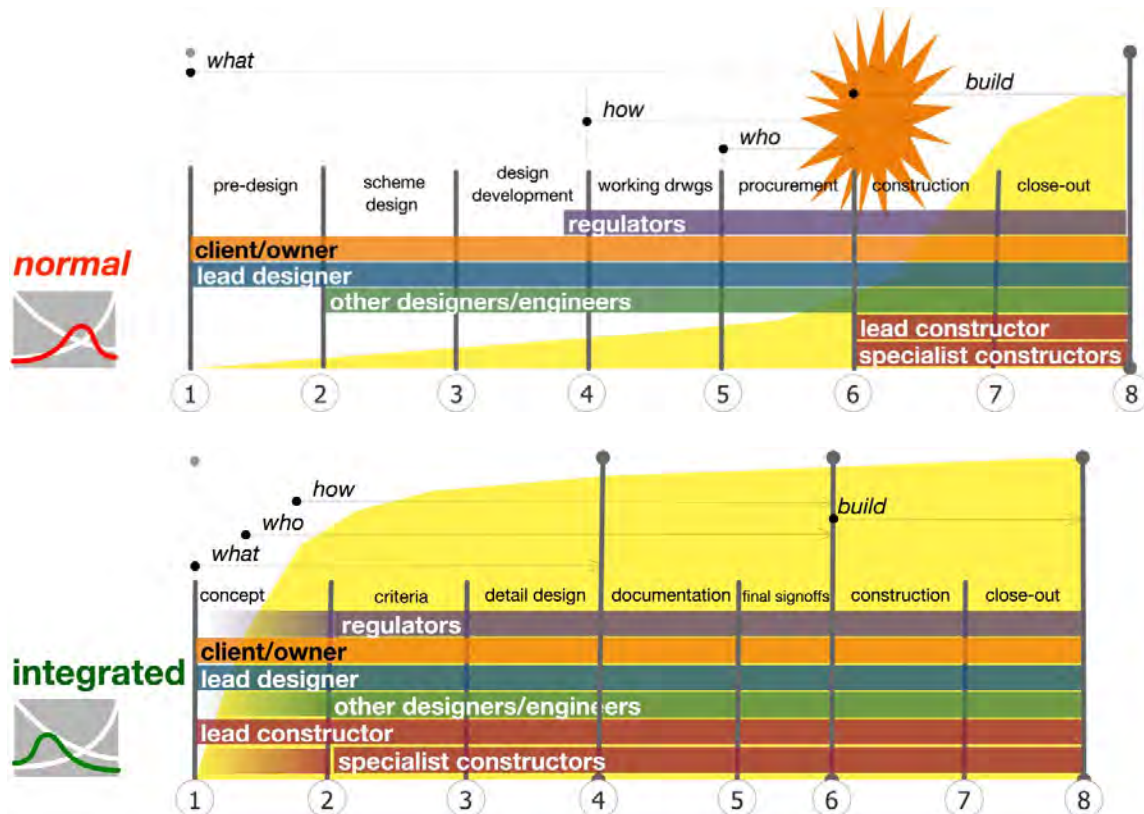


Figure 18: Comparison of normal and integrated project delivery timelines (after Eckblad et al 2007) & their impact on the development of a shared understanding of the project by the whole team (shown by yellow area – from Will Lichtig 2007; Lichtig suggests shared understanding may never reach 100% in normal). (graphic: after Mossman 2008)

The top diagram in Figure 5 shows what happens in a typical design-bid-build project. The client hires a designer, the designer takes a brief and hires additional sub-designers. They design the project, discuss it with regulators and when they have approval they invite tenders from general contractors. The contractors prepare their bids bearing in mind the gaps that they can see in the project documentation. Many of those gaps will be identified as potential opportunities for future claims so that, even though they are submitting a bid at or below cost, they will still be able to make a profit on the back of the claims they make. If, as often happens, bids are above the client's budget, the project is generally descoped to bring it within the budget and further bids are requested. Once chosen the lead constructor suggests/requests design changes to make it easier to construct the project and assembles the delivery team (who are also generally chosen based on lowest cost). The level of understanding of the totality of the project by the design and delivery organisations (yellow area) is at the best very poor — and frequently does not reach 100%, even by the end of the project.

The bottom diagram illustrates key differences with IPD.

- Early involvement of key delivery team members
- Integrated working with regulators/ auditors
- Client integration throughout process – especially in design
- All team members develop good understanding of the totality of the project
- Production system designed alongside product design.

7.4. What are the origins of IPD?

The use of collaborative/relational contracting to improve the performance of construction type projects emerged in the 1990s in the UK process industries. It built on the previous ideas of partnering by incorporating them into a contractual agreement. Known as *Project Alliancing*, by the early 2000s its use had spread to the public sector in Australia and from there to Finland in the 2010s. The term IPD emerged in the USA in the early 2000s during initiatives to address poor project outcomes of *normal* construction methods – they fail to deliver projects to cost, schedule, and quality (Ashcraft, 2022). To overcome these limitations, Will Lichtig created a multiparty agreement, the *Integrated Form of Agreement* (IFoA) (Lichtig, 2006) for Sutter Health. The IFoA requires key delivery partners to pool their proposed profit *at risk*, jointly manage the project through consensus, and use lean processes during design and construction. In 2007, an American Institute of Architects, California Council group named this approach *Integrated Project Delivery* (IPD) (AIA CC 2007). IPD is an approach to agreements and processes for design and construction (Zhang & Chen, 2010).

How Sutter Health (SH) got started

- Following a severe earthquake in 1994, the State of California introduced building code laws requiring all essential buildings such as hospitals and fire stations to be able to withstand a seismic event and continue to operate by 2013. By 2001, SH knew they had around \$13bn worth of construction to deliver in the next 12 years to satisfy these requirements and they had to self-fund this work.
- Traditional contracting methods were delivering projects late and over budget, so SH decided to rethink the delivery model.
- In 2004, SH told its supply chain that henceforward they would only procure projects on a lean basis, seeking a better way to work together. SH understood the principles that would lead to success and called these their “5 big ideas”.
- In 2005, Will Lichtig, SH’s legal counsel, drafted a relational contract for SH - the *Integrated Form of Agreement* (IFoA) that brought together lean thinking and the ideas of Project Alliance (from UK & Australia). This was initially used as a three-party contract – SH, lead designer and lead constructor.
- At about the same time they formed a Community of Practice (CoP) to help themselves and their current and aspiring delivery partners learn and develop the new way of working with the active support of lean construction academics and consultants.
- By 2007, after some early mixed results, they ran the first project with more than just the lead-designer and the lead-constructor signed up to the IFOA.
- Subsequently United Health Services (UHS) followed a similar path. Both organisations had leaders who were members of the Lean Construction Institute in the USA and the International Group for Lean Construction (IGLC) communities. The Project and Production Systems Laboratory (P2SL) at the University of California Berkeley has been particularly influential in supporting the development of ideas and encouraging research in IPD. In the process they have attracted students from many parts of the world to join in that research which has been disseminated through IGLC and journal papers.
- These ideas have subsequently spread back to Australia (known there as Project Alliancing) and on to Canada, Finland, Ireland, Germany, Estonia, UK, HK, China and elsewhere.

Today there is a significant body of knowledge about and experience with IPD and its undeniably superior performance in building construction (outlined in Chapter 3). The evidence for infrastructure projects is more limited but still good.

7.5. IPD Project Governance

The aim of governance is to prevent *the normalisation of deviance* (Vaughn 1996) or, in other words, to minimise counter-productive behaviour (Pinto 2013) and “*the regulation of social behavior through networks and other non-hierarchical mechanisms*” (Fukuyama 2016). Hall and Bonanomi’s paper (2021) is an important contribution to a discussion on governance.

Firstly, drawing on practice-oriented research describing specific new work routines, management practices and mechanisms for collaboration used on collaborative projects, they describe the differences between the governance of collaborative project delivery models such as IPD and classical project delivery models. The practice-oriented literature they reviewed failed to show how project governance fundamentally changes in collaborative project delivery models.

Second, the article shows how definitions of resource systems, resource units, appropriators, providers, and producers from common-pool resource scholarship can be used in the project management domain. Using the *tragedy of the project* the authors explain the degradation that can occur in a pluralistic setting when project firms continue to overdraw resources from a shared project budget.

Third, drawing inspiration from the Nobel Prize-winning work of Elinor Ostrom, the article explains how Ostrom’s design principles can be found in many of the best collaborative project delivery models. There are examples throughout the article.

It is not clear to us how RDP and SMP Alliance governance processes match up to the governance design principles that Ostrom identified in 2015 (Hall and Bonanomi 2021, Table 2):

- Clearly defined boundaries for common-pool resources for users and for the resource
- Congruence with both local conditions and between appropriation and provision rules.
- Collective – choice, arrangements.
- Monitoring users and the resource presence and accountability.
- Graduated sanctions.
- Conflict-resolution mechanisms.
- Minimal recognition of rights to organise
- Nested enterprises

The reporting relationships and accountabilities of client and delivery partner organisations are rarely adequate for project governance – they exist for a different purpose, often differ and sometimes conflict. Projects need a management and administrative framework to organise all of those involved — a project governance system (Zwikaël and Smyrk 2011). Project governance helps project teams deal with issues like:

- Potential and actual conflicts of interest
- Defining the project independently of its “parenting” organisations
- To enable the project owner(s) to be held accountable for target outcomes
- To be able to distinguish between purchasers and providers
- To enable project managers to be held accountable
- To establish the roles of each significant project participant

Zwikaël & Smyrk (2011) offer a generic project governance model (Figure 19). The elements are described below.

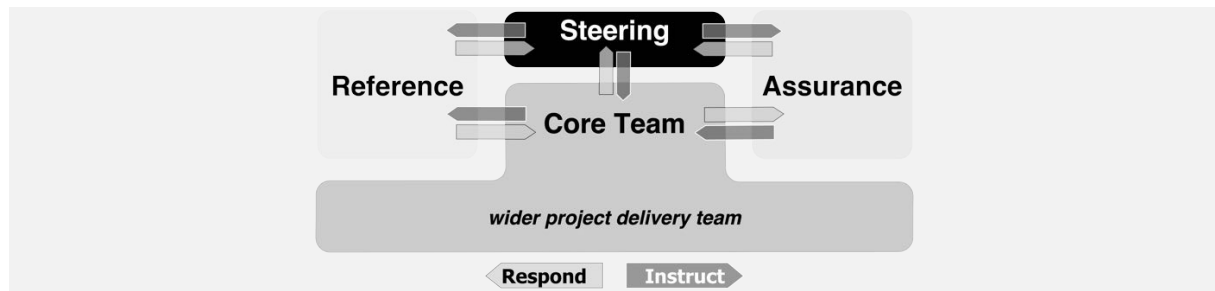


Figure 19: A generic project governance model (after Zwikaël & Smyrk 2011, 99).

Steering = the project client and the steering committee (they may be the same). The steering committee approves significant changes in project documents and parameters and guides the project towards a successful outcome.

Delivery = all those responsible for producing the project's outputs and those responsible for administering delivery. The project team has many component entities such as sub-teams, cluster groups, consultants and suppliers. The structure adopted for a team will depend on the peculiarities of the project and could be based on: skills, functional areas, outputs, contracts or type of work. The larger and longer the project the more it is likely to evolve over time.

Reference = those providing specialised input to the delivery team and/or the steering group. Again, there may be many reference entities – individuals and teams.

Assurance = those responsible for independently monitoring the conduct of the project on behalf of the steering committee. The two most common are project assurance (ensuring the project is conducted in accordance with the project management framework) and probity (ensuring that commercial dealings between project participants and the outside world are managed in accordance with agreed commercial guidelines). Not all projects require these roles.

Elements of the construction sector in the USA and elsewhere are developing new project governance systems. Contractual incentives are used as well as planning and evaluation tools that focus on the values of different stakeholders. Integrated governance clarifies the responsibilities of each party for contributing to value generation and makes it easier to get consensus decisions using the unique and complementary knowledge of suppliers and consumers. This is opening channels for value co-creation (Tillmann et al 2012).

Figure 20 shows a governance structure developed for public sector infrastructure projects using the *Project Alliance* model in Australia 20 years ago. Project Alliances are a forerunner of IPD (see previous section).

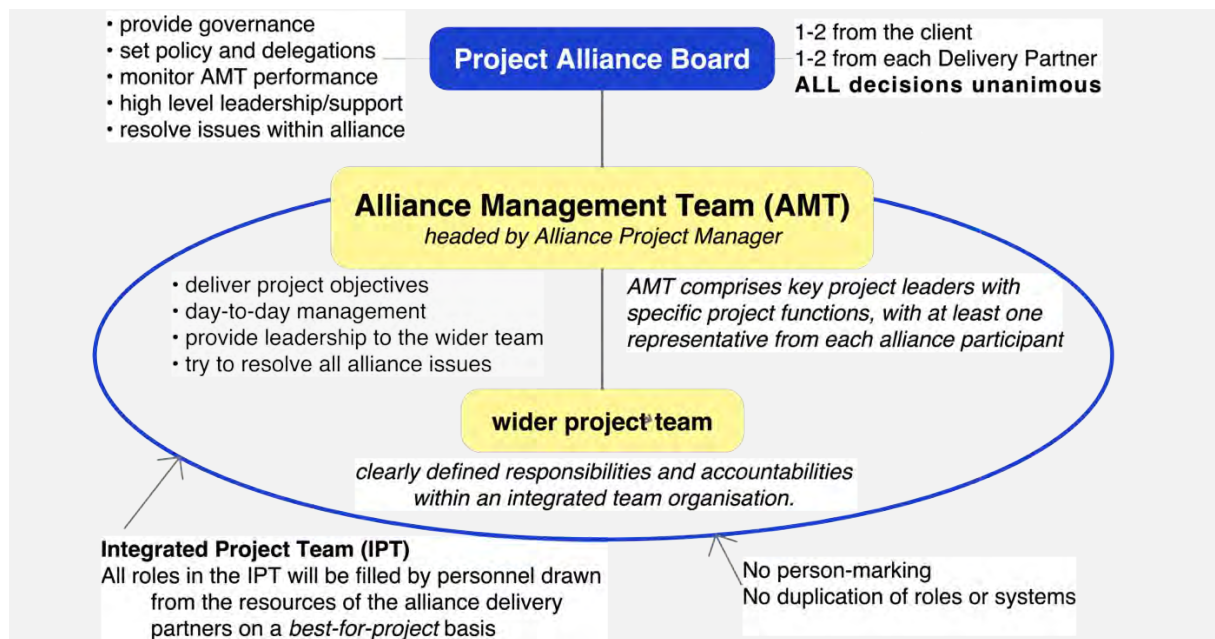


Figure 20: Illustration of the governance structure of a typical Australian public sector Project Alliance (a forerunner of IPD). after Ross 2003.

Note that the Project Alliance Board is made up with representatives from the client (owner) and the delivery partners (NOP = non-owner participant). PAB members are explicitly not involved in the day-to-day running of the project. PAB decisions are made by consensus. The PAB monitor the progress of the Core Team (The Alliance Management Team) running the project.

Ross (2003) notes that under “a project alliance, in the absence of traditional contractual roles and in the enthusiasm for a “no blame” integrated team culture there is a risk that accountabilities and responsibilities can become blurred. He says it is essential that accountabilities and responsibilities are clearly established throughout the team right from the start and underpinned by a culture where people at all levels do what they say they will do.”

The governance of collaborative project delivery models such as IPD differs from *normal* delivery models in three ways (Hall and Bonanomi 2021):

- “the multiparty relational contract creates a shared financial resource pool for the project. The project resources become contractually available for free use by any signatory party.
- “to manage these shared financial resource pools, the participants of IPD projects share decision-making rights over the future of the project. This requires parties (including the client) to take time to reach mutual understanding, strike consensus and align decisions and actions. Shared decision-making rights can reduce uncertainty and de-risk projects, but without proper governance structures they can increase the risk of inaction among pluralistic stakeholders.
- “the parties share financial risks and rewards of the project outcome. Project teams must self-organize to determine the appropriate payoff rules. IPD adds complexity by extending this arrangement throughout the entire life of the project— from validation to commissioning. “

The different behaviours these differences demand are all supported by, for example, Big Room collocation (see 7.13), Target Value Delivery (7.15) and Choosing By Advantages (7.17).

In 2012, Tillmann et al studied the governance on a Sutter affiliated IPD project in the USA and concluded:

*“... that IPD enables an environment in which value can be co-created, as it shifts the customer versus supplier relationship into **customer plus supplier**. Customer expectations and supplier assumptions are challenged in a dynamic and collaborative environment. While this can represent great improvement in generating value from construction projects, the increased managerial challenges of such interactions should also be noted.”*

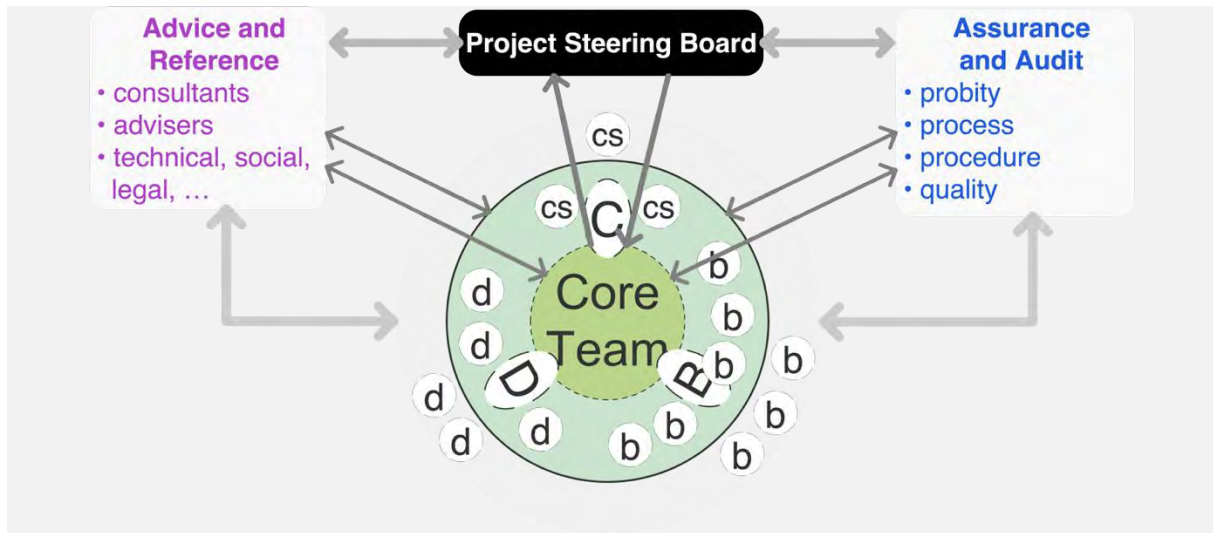


Figure 21: A project governance scheme for IPD projects that brings together ideas from Ross 2003, Zwikaël and Smyrk 2011 (Figure 19), and others. (C = client, cs = client support, B = lead builder, b = specialist builder, D = lead designer, d = design specialist)

7.6. Incentives

The incentives on an IPD project are part of the governance process. They are designed to get the delivery partners collaborating with each other and the client for the good of the project. It requires the parties to build and maintain their relationships (Zhu and Cheung 2023).

Governance structures must be arranged to manage both the initial allocation *and* later distribution of project resources in order to fairly distribute the overall project reward (incentive pool) for all participants (Hall and Bonanomi 2021).

As well as the incentive pool (see Figure 24) focusing the delivery team on delivering within the budget, a limited number of KPIs (Key Performance Indicators) in strategic KRAs (Key Result Areas) can help the delivery team focus on key customer non-cost performance targets such as sustainability, quality, scope, safety, schedule, community, traffic, relationships or appearance (Walker, Harley and Mills 2015, 4). These few KPIs will generally enable the delivery team to collectively add to the incentive pool; KPIs can also be structured to result in a reduction in the incentive pool if the result is not adequately delivered.

When a project is delivered below the target cost (Figure 25) an agreed proportion, say 50%, of the resulting savings are added to the pool. If there was no limit to the amount that could be added to the pool, the delivery partners are presented with a perverse incentive to negotiate as high a target cost as they can during the validation phase (Figure 24). To reduce the likelihood of that happening, it is normal to cap the amount that can be added to the pool from underspending. This cap is often at 150% of the original pool. Rewards for meeting KPI targets can increase the pool more than this.

Construction incentivization should get the contracting parties working together. In this respect, managing behaviours between the parties should be one of the planning norms of construction incentivization. Empirical support is also provided.

Many projects with incentives still end with project overruns, huge claims, and embarrassing defects. Clients in Hong Kong and China have been using Project Alliances/IPD for about 15 years. Researchers based in Hong Kong and Shanghai (Zhu and Cheung 2023) suggest defective design is a key reason why incentive arrangements fail.

Another researcher studying IPD in Hong Kong (Ma 2023) has observed that compared to any other procurement strategy, IPD has a larger risk/reward incentive pool than other approaches. This, she believes, is why IPD empowers effective multidisciplinary integration. She notes that some potential delivery partners are unwilling to put all their desired profit at risk.

7.7. Some Defining Characteristics of IPD

As Attouri et al (2023) note “*Normal* construction systematically separates design from production. The construction sector is the only major industrial sector where this still happens. The result is that designers lack good cost information during design and they frequently produce designs that are difficult to build. This often means that designs need to be reworked (de-scoped) to meet the client cost criterion and to make the project more buildable. On many projects, this separation creates claims, conflicts, mistakes, costly corrections (rework), and delays.

As construction projects become more complex, there are increasing schedule and cost pressures and a growing quest for sustainability and quality. These pressures, the fragmentation of the construction sector and the adversarial relationships that flow from the use of *normal* bilateral, transactional and adversarial contracts put the people involved under significant stress.”

Further characteristics are listed in Table 2: List of IPD characteristics.

Rather than provide extensive descriptions on each of the 36 characteristics, we will summarise our findings based around the five key areas of value proposition, contract, culture, processes and technology, expanding on these where we think essential to provide insight into IPD with the minimum amount of effort by the reader.

A 2016 survey of USA construction customers by Dodge data and analytics revealed that the top six project/team management and operational differentiators of typical and best performing projects to be:

- Co-location Big Room
- Target Value Design
- 3D BIM Coordination
- Conceptual/Continuous Estimating
- Visual Management
- Last Planner System®

Most Impactful on Performance

- Timing: **Engage key stakeholders as early as possible**
- Team selection: **Best Value**
- Form of agreement: **IPD**

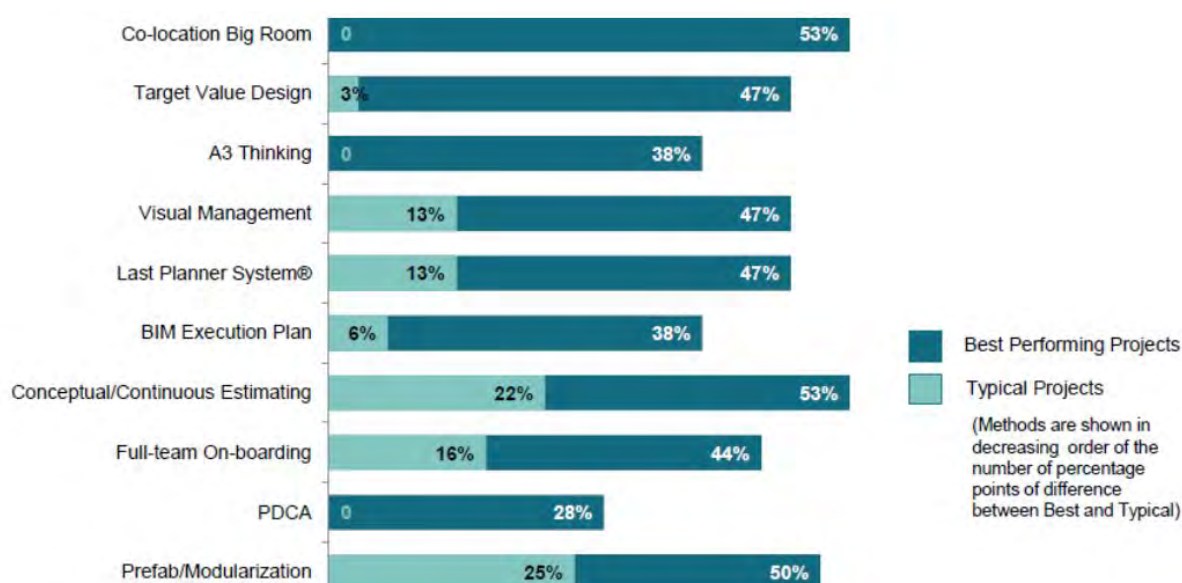


Figure 22: 10 biggest gaps between typical and best projects. Notice - almost all have lean origins, BIM and prefab are the exceptions. (source: Mace and Laquidara-Carr 2016)

7.8. Value Proposition

Value is ‘what the client wants’. The first principle of Lean is understanding value *from the perspective of the customer*.

In an IPD project, during the validation phase significant effort is expended to define the value that the project must deliver and then articulate this with metrics that can be tracked & reviewed as design and construction progress.

Value is defined from five key stakeholder perspectives – all of whom are ‘next’ customers in lean.

- The Client – It meets the client’s business case
- The Builders - Buildable (Is this the best way for us build it?)
- Design for assembly by engaging with those that will do the assembly in the design stage
- The Maintenance Crew. Operable (Is it easy & efficient for us to maintain?)
- The Mechanical, Electrical and Plumbing (MEP) systems and structural systems are considered fully from a maintenance point of view, engaging with those who will operate the facility.
- The operator of the asset – Useable - Will we be able to easily use this?
- Designed with the end user in mind and how they will most benefit from the facility
- Sustainable — In harmony with the environment

As well as using the incentive pool to get the delivery team to focus on delivering within the budget, in strategic KRAs (Key Result Areas) a *limited* number of KPI (Key Performance Indicators) can be used to focus the delivery team on other key deliverables for the client. These KPIs will generally allow the delivery team to add to their incentive pool.

7.9. Contract

IPD uses a relational contract —a single agreement that all key participants sign including, at least, the client, lead designer and lead builder. Specialist trades and specialist designers are often added to the contract when they can significantly affect the project outcome. Use of these

relational contracts is common in Australia, New Zealand, the USA (Gokhale, 2011) and more recently in Hong Kong, China, Canada and Finland. Clients in other countries are catching on.

We are not contract law experts but our research found the form of contract matters a great deal. Sutter report that they did not get the behaviours they were looking for in their supply chain until they introduced the Integrated Form of Agreement — a *relational* contract. The key features of the contract are listed in *Table 1*. The client, lead designer and lead constructor are the minimum signatories, and the number can be up to 20.

Figure 23 shows a typical relational contract arrangement that has emerged over the last 12 years or so. The design specialists and specialist trades and builders within the green circle are generally those with the ability to significantly affect the overall success of the project. For example, in a highly serviced structure, the designers and constructors of the key services will be on the inside to encourage the commitment to being full advocates for the project.

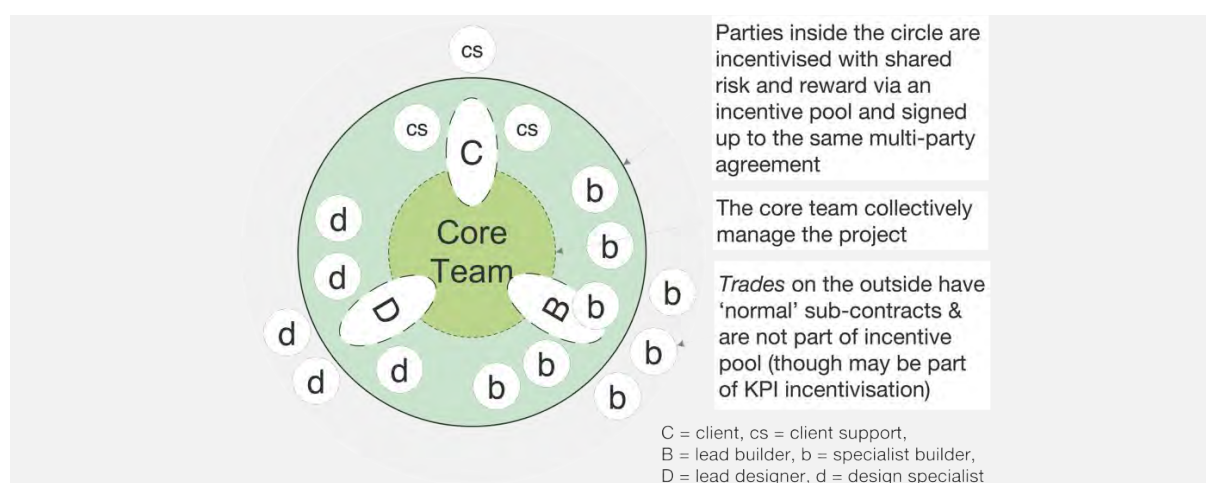


Figure 23: Basic management structure of an IPD project

An important function of the core team is the full systems integration of the project. Each of the main parties to the relational contract may have a specialist systems integrator; the core team must ensure that their work is being done effectively. Systems integration is a major challenge in delivering a complex project. Many organizations deal with complexity by breaking a project into different elements with clearly defined buffers and interfaces. The core team must ensure that this enables the elements to work together when necessary.

A classic example of the failure to pay sufficient attention to systems integration is the crisis that led to the delay in the opening of Crossrail – The Elizabeth Line in London. The integration of the diverse signalling systems was given insufficient attention during design.

Core Teams tend to function better when they are kept small, e.g. Client, Main Contractor, Lead Designer and, maybe, two or three representative specialists. Decision making becomes more difficult when the core group gets too big (Knapp et al 2014).

If key trades are not included in the relational contract they can be procured with back-to-back contracts so they are party to the overall risk/profit deal in some way. Specialist trades like painters and landscape designers and contractors are most likely to be on the outside and procured in a “normal” way.

The IFoA, a relational contract, states simply that “*The functioning and operation of the Project shall be governed by the Core Group*”. Consensus 300 (another relational contract derived from IFoA) adds “... which shall serve as the decision-making body for the delivery of the Project and

shall employ collaborative methods for achieving the highest quality and most efficient and economical delivery of the Project”.

Some, but not all, IPD relational contracts require the use of one or more lean processes. These include Last Planner System, Choosing by Advantages, Target Value Design, A3s.

7.10. Agreeing costs and getting paid

In IPD projects the client and signatories to the relational contract agree the amount of profit and contribution to corporate overhead that each party wants from the delivery of a successful project. These sums are added to the incentive pool for the project. Figure 13 shows an example. The percentages in the table on the left-hand side dictate the percentage of the final profit pool that each party will receive at the end of the project.

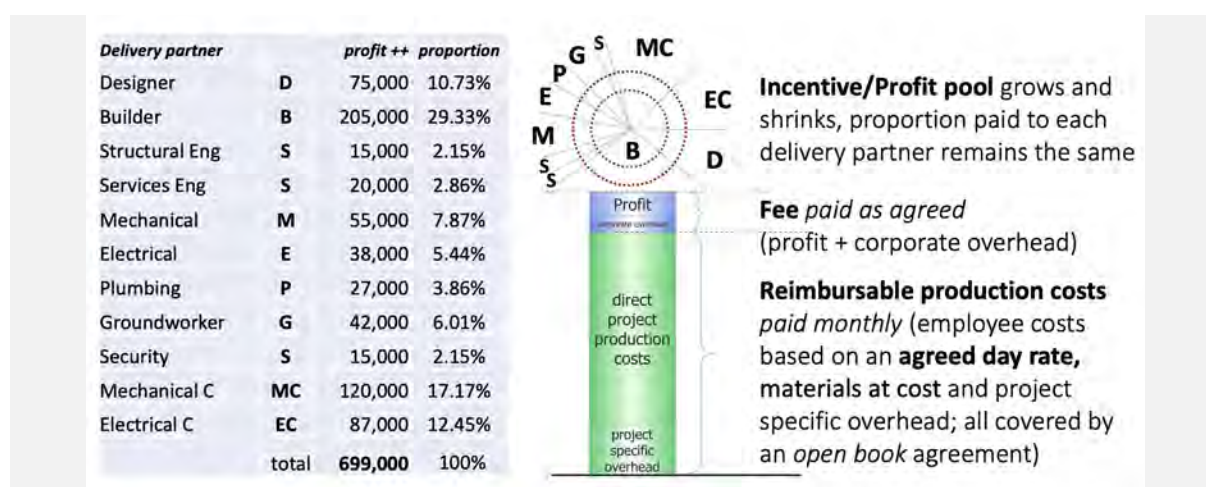


Figure 24: How do delivery partners get paid? Project production cost payments and incentive pool (= fee) (graphic: Mossman 2023 with permission; image derived from Ross 2003; Wilson 2014; Morwood, Scott and Pitcher 2008; Fischer et al 2017).

Once the amount of profit and corporate overhead are agreed, the client and lead delivery partners agree the overall price for delivering what the client wants within the *Validation* phase. The Allowable Cost for the project is the target price less the total agreed profit and corporate overhead. Some delivery teams agree a target lower than the Allowable Cost where the difference is in effect a contingency sum, a sum that they plan to eliminate.

The client pays delivery partners all their production costs – employee costs based on an agreed day rate, materials at cost and project specific overhead – monthly in arrears. If the total production costs exceed the Allowable Cost, the incentive pool is reduced to compensate the client.

Working in a crowded healthcare market in Northern California, Sutter can benchmark the prices of the facilities they want against those delivered to local competitors. On several projects they have negotiated target costs with their delivery partners that are 10-15% below those achieved by competitors.

If the delivery team reduce the amount they spend on staff time, materials, etc., (their production costs) an agreed proportion of the savings are added to the profit pool that holds the profits of all delivery partners (if delivery partners spend more than the allowable cost on production the profit pool is reduced by a similar amount [Pain share]). At the end of the project the profit pool is divided between the delivery partners in the proportions agreed at the start of the project [Figure 13]. This incentive aligns the interests of the designers and constructors

with those of the client (to build a project that meets the needs of client and end-users within the client's budget). This helps the customer have cost certainty while enabling the delivery team to increase their margins.

Delivery partners can often add to their profit incentive pool by meeting one or more KPIs.

7.11. The Delivery Process

Before starting an IPD procurement process the construction client prepares a business case for the facility they are considering. The business case includes information about the economic and other benefits to the client organisation of the proposed facility as well as a review of how much the organisation is willing to pay to acquire those benefits. Once the business case is clear, the client goes to the market to find delivery partners with whom they can work to deliver the facility and who will work well together.

Figure 25 shows the process flow of a typical IPD project. Notice that the key project delivery team members are assembled from the beginning first to work together, second to understand the business case of the project, and finally to check whether the delivery partners believe that the project can be delivered within the budget proposed by the customer. This is the *Validation* process. Negotiating the *Conditions of Satisfaction* for the project is integral to this part of the process. If the delivery partners collectively feel that they can deliver for a price the customer is willing to pay, the contract is signed and they work collaboratively to deliver the project.

From (3) the delivery team designs both the facility and the production system so that the scope requested by the client is delivered within the time and agreed cost using Target Value Delivery (TVD). Predicted project cost is tracked continually, and total estimated cost updated every 2 to 4 weeks.

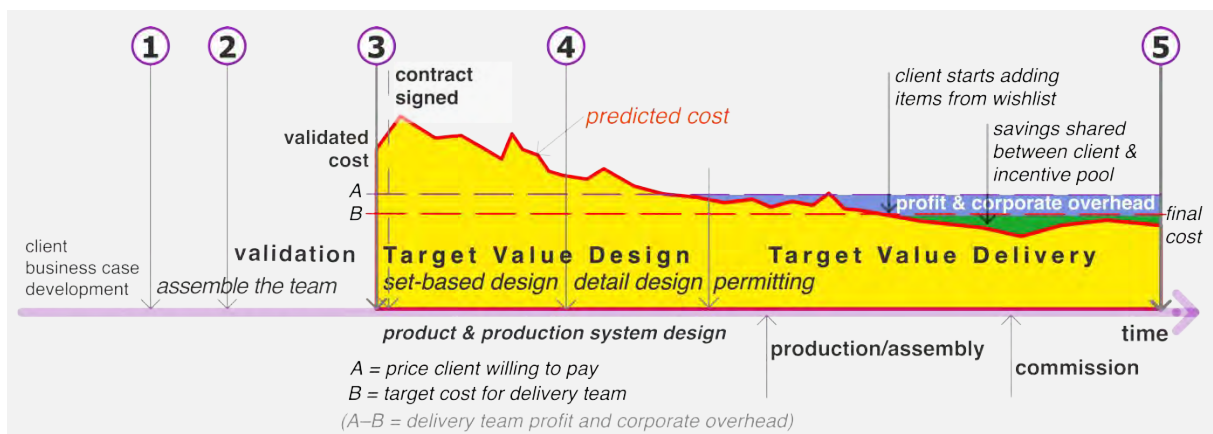


Figure 25: IPD/TVD process flow (graphic: after Attouri et al 2023)

Because constructors are already members of the delivery team, it is **they** who provide the cost estimates; they have *skin in the game* and it is in their interest to produce the best possible estimate they can. Initial estimates are based on the conceptual design. Conceptual estimating is a particular skill.

TVD requires that the team design to a detailed estimate (rather than price a detailed design). So good **conceptual estimating** is key to success in TVD. *"The ability to conceptually estimate gives the project team power to make value-added decisions that benefit the customer. Additionally, this estimator becomes a significant contributor and usually acts as an IPL."* (Seed 2014)

As details of the design become clearer the estimates become more and more accurate and monies that may have been initially allocated to contingency diminish. The predicted cost between (3) and (5) generally tracks down.

Rarely is the first estimate that the client receives on a normal project the final cost that they pay. Figure 26 illustrates a key difference between normal projects (dotted line) where the estimated cost of a project typically rises over time, even after the contract has been awarded, and IPD projects using TVD (solid line).

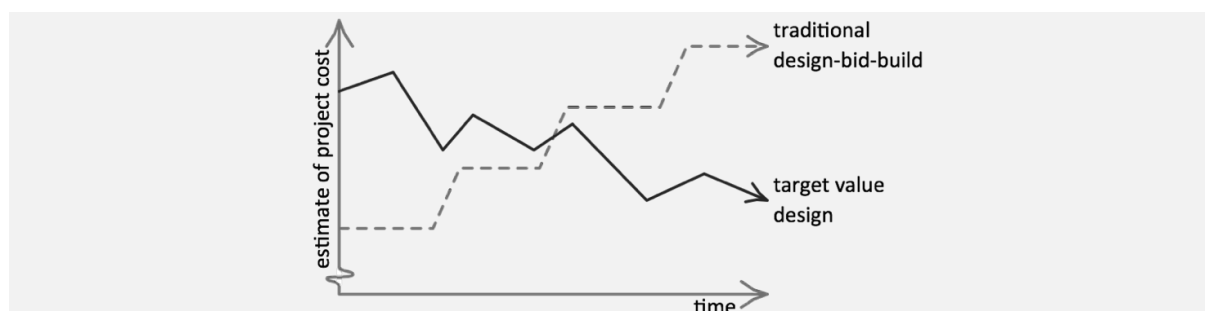


Figure 26: Cost of normal construction vs IPD using TVD (source: Mike Tesmer in Rybkowski 2009)

At some point in an IPD project the predicted cost falls below the total price the customer wants to pay (A) and there is *some* money in the profit pool to be shared between the parties⁶. When the predicted cost tracks down below the allowable cost (B) some of the savings made are added to the agreed profit pool. Some customers use the savings that they receive to buy additional scope from their *Wish List*. This too adds to the funds in the profit pool.

If, on the other hand, the reimbursable costs exceed the total agreed with the customer the profit pool shrinks so that the customer is not out of pocket. Most customers recognise that if they wish to retain the project team as *advocates for the project* they need to ensure that the parties do not make a loss. What this means is that team members may make no profit but all their costs will be reimbursed and the customer will pay anything over and above the reimbursable cost plus fee agreed at the start of the project. So far as we are aware this has never happened.

If delivery partners were forced to make a loss if a project exceeded the target price they would not agree to a low target price in the validation phase and if they still exceeded the price delivery partners would cease collaborating in the same way and seek to protect themselves.

If projects do start to overspend participants tend to “reverted to type”. Sutter have found that success relies on client leadership skills “being in the room”, close monitoring of behaviours & culture. Sutter reported two projects suffering a reverting to type problem but both were recovered by their leadership being able to manage relationships with delivery partners.

Measurement systems used are:

- Budget Adherence
- Programme Adherence
- Productivity – planned vs actual hours
- Behaviour/Culture (PPC (Percentage of Promises Completed), “wordle” pulse surveys)

⁶ If the price doesn’t fall below what the client is willing to pay, there are provisions in the contract to allow the client to terminate. If that happens the delivery partners receive all their reimbursable production costs to date and a proportion of the profit that they agreed for the whole project.

In addition, both Sutter and Seed report that when things didn't go so well it was because the *selection process* failed to establish cultural alignment with and between delivery partners.

7.12. Culture

The successful organisations in Finland continuously measure culture as a KPI as do other successful IPD clients including Sutter.

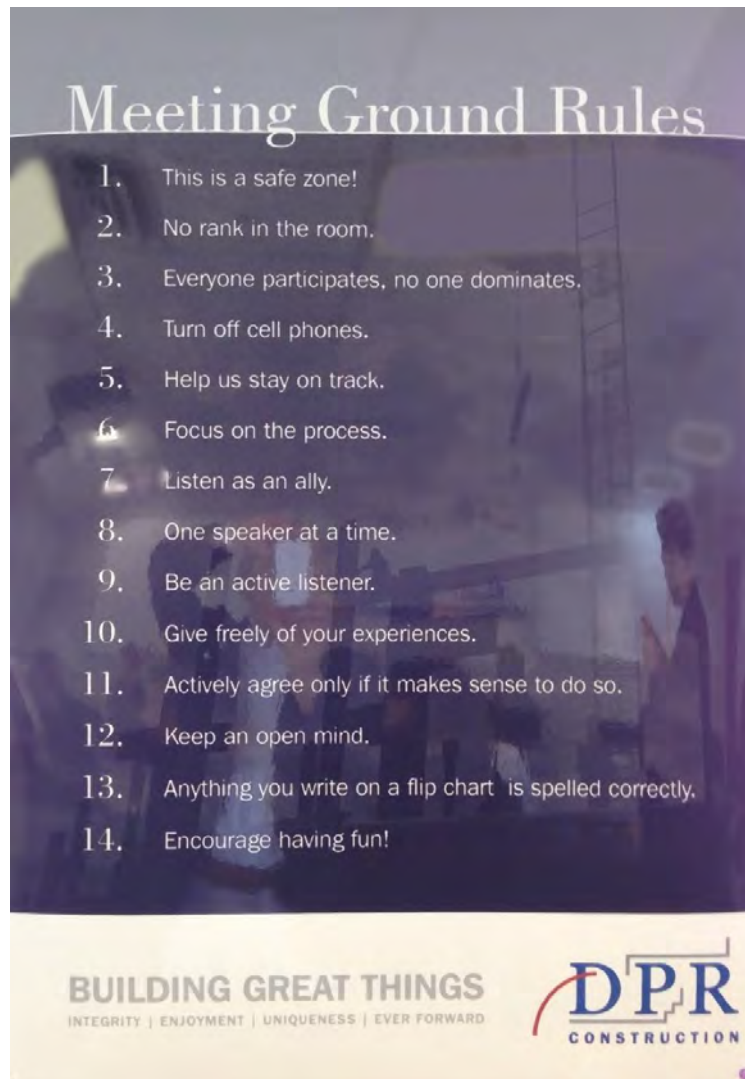


Figure 27: Behaviour reinforcement: DPR Meeting Ground Rules poster in the San Francisco Chinese Hospital project big room. (photo Mossman 2012)

A key characteristic of IPD is that *the Client actively co-leads the delivery team* and is critical to establishing and maintaining the required behaviours and culture. Sutter credit much of their success to strong internal leadership skills and state they have five experienced “in-the-room” IPD leaders. These individuals are permanently assigned to major projects. The concept of the servant leader is key, understanding that the “Value Creators” are those that do the design or the work onsite. Everyone else is there to support the value creators. This transition is shown in Figure 28 below.

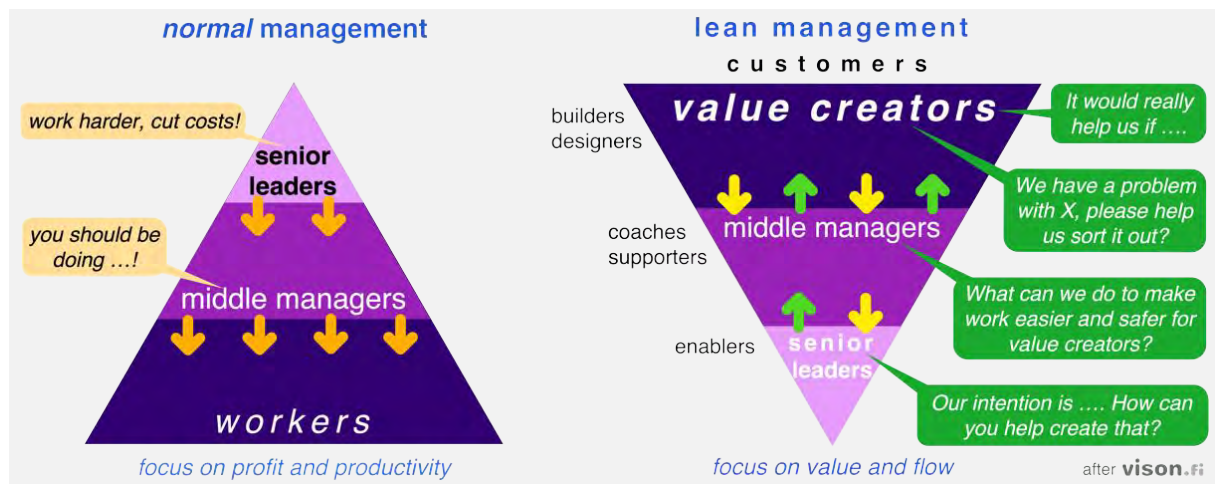


Figure 28: Make the transition to putting the Value Creators on top and working to make it easy for them to do their work.

7.13. Collocation – Big Room

Big Rooms are a key enabler of an appropriate project culture and good IPD and TVD processes. This physical space, a common workplace with common rules and tools, is the project design and coordination office where people meet face-to-face, work in cross-functional cluster groups and manage the design and construction process. The space:

- facilitates the free flow of information, communication, collaboration, innovation, teamwork, and productivity
- creates a group identity

As illustrated in Figure 29, Szyperski et al (2023) note that collocation:

- helps to integrate large interdisciplinary groups;
- helps projects run more smoothly;
- encourages collaboration;
- enables fast decision-making and information exchange;
- effective communication and information exchange;
- helps build relationships and trust. Trust is a prerequisite of teamwork, crucial for collaboration and for IPD projects, and needs to be consciously built from the start;
- allows partners to gain an understanding of each other, learn each others' (professional) languages and ways of thinking leading to an increase of trust over time.

Tampio and Haapasalo (2022) add:

- creates an effective framework for quality project management.
- improves communication, interaction and team spirit.
- Creates a low threshold for sharing data, which accelerates decision-making.
- actively produces solutions to prevailing problems and devises new ways to solve them.

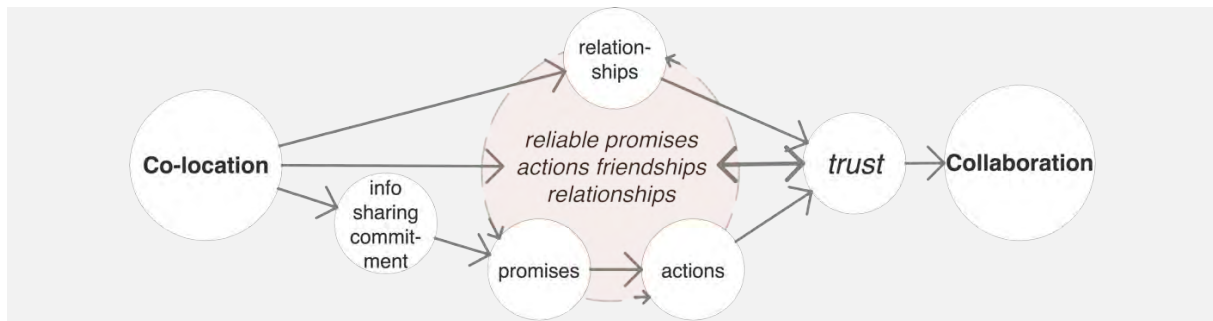


Figure 29: Collocation creates the pre-requisites for collaboration (after: Szyperski et al 2023)

Writing before the pandemic, Hosseini et al. (2018) found *collocation to be the fourth most important partnering element*.

Walls in a physical Big Room are generally papered with lots of visual information like charts, schedules and trend lines that display the current state and effectiveness of a project, as well as current thinking about issues, studies and so on that affect the whole project.

This kind of information is not so readily available to team members working in *virtual big rooms* — they must actively seek it (or have it drawn to their attention) rather than noticing it on their way to see another member of the team, to the water cooler, coffee machine, kitchen, meeting room or the loo.

IPD requires intense collaboration. This is more likely face-to-face. Projects in Finland work to a “pulse” of two or three days every two weeks as an effective compromise. Sutter’s Eden Valley Medical Centre project co-located every other week. Effective production control, proper use of the Last Planner System and the use of other lean construction techniques are required to run an effective collaboration hub.

Szyperski et al (2023) list five types of collocation:

Full-time — completely in-person, 4-5 days a week at the collocation. This is what Toyota does. The venue can be close to the partner’s offices during design and must be close to site for construction.

Part-time — 1-3 days a week at the collocation and the rest is hybrid or virtual.

Pulsed — say every other week or one week per month in the collocation. Focus on releasing work when in the collocation. The low mandatory presence means that some processes need to be given higher priority to compensate for the time missing in the physical collocation.

Part-virtual — an almost completely virtual collocation except for workshops which are done in-person. This can work for smaller projects.

Virtual — a virtual collocation with options for virtual or augmented reality

For each type, except full-time, office hours need to be set. Establishing clear expectations of when partners need to be present is imperative for a part-time, pulsed and hybrid collocation to function. If agreed, *Co-located telecommuting*, allows partners to work on other projects while present in the collocation.

There is a variant that can be used with any of the first four:

Rotating — This is when the collocation is at one of the partner's offices and rotates between the various offices depending on the phase and needs of the partners.

Design Structure Matrices (DSM) are a way to identify when collocation is essential. Find more information in Tuholski & Tommelein 2008.

Bosch-Sijtsema and Tjell (2017) describe three inter-dependent issues related to using a collocation space effectively: the way users experience and interpret the physical space and how the space determines their behaviour (architectural determinism); the way users respond to the power relations in the space; and users ability to interact socially and professionally. These three elements are dependent on each other and cannot be studied alone.

Szyperski et al (2023) interviewed 26 people with significant experience of collocation. The interviews show that hybrid collocation concepts can be successful, however, no-one recommended the long-term implementation of a totally virtual collocation. In-person events need to be at the beginning and throughout the project to build and maintain trust. As the degree of hybridisation increases, serendipitous communication decreases. Interviewees emphasised that other communication channels such as LPS need to compensate for these missing interactions.

Sijtsema and Tjell (2017) report that employees separated by more than 30 meters are much less likely to communicate informally; A close shared social physical setting builds a similarity of expectations and experiences; Especially in relation to knowledge sharing, collocation supports rich face-to-face interaction, development of a shared context and facilitating tacit knowledge transfer. As Mossman and Ramalingam 2022 note, most knowledge in construction is tacit. It is not codified or explicit – another reason why collocation is so important.

Figure 30 gives you an idea what a big room looked like a decade ago (Eden Valley Medical Center was completed in 2012). It really is a big room with conference spaces off. During Design the delivery team collocated alternate weeks.



Figure 30: Big Room at Sutter Health's Eden Valley Medical Center Project during the construction phase. (source: Dave et al 2015)

A recent article in *The Economist* ("The working-from-home illusion fades", 28Jun23) reported that stories suggesting working from home was more productive than toiling in the office have

not stood up to scrutiny. Recently published research of a randomised control trial by MIT researchers Atkin, Schoar and Shinde (2023) found the **productivity of workers chosen to work in an office was 18% higher** than those chosen to work at home. Two thirds of effect was visible from day one and the rest is attributable to **office-based workers learning faster**. This data seems to present a strong argument for insisting on at least same-day pulsed collocation for all staff on a given project. IPD is a new way of working and it is important for the whole team to learn this new way. Other authors are counselling caution on encouraging teams to return to the office.

7.14. Lean tools and techniques

Bolting lean tools & techniques onto a fundamentally flawed system will only ever yield superficial results. However, once system enablers such as Systems thinking, IPD incentive pool, TVD, and the like are in place, these processes can deliver exceptional results.

7.15. Target Value Delivery (TVD)

TVD is a process and a culture that will deliver a project within the defined goals of the team.

“cost isn’t a surprise to the outcome of design; it’s a partner to the design.”
Martin 2015

One cannot discuss IPD without a basic understanding of TVD as it is a principal process. TVD provides a proven & practical approach to *Left-Shift* thinking in a construction setting.

Target Value *Design* was first described in a paper by Ballard and Reiser (2004). The project was completed in 2002 using a Design-Build contract. Jackson Healthcare, a public sector Healthcare organisation in Florida, have completed IPD-lite projects with full TVD using back-to-back Construction Management at Risk contracts. These examples demonstrate that **IPD relational contracts are not essential for TVD** (though TVD is an integral part of IPD).

TVD differs from traditional capital project delivery in that the team’s interests are aligned, collaboration is incentivized and it enables the use of lean tools necessary to continuously innovate during the project to bring the expected cost down over time (see the solid line in Figure 26, the *predicted cost* line in Figure 25 and the red *estimated cost of the original scope* line in Figure 2). This is a revolutionary idea. It is why clients with large capital project expenditures and contractors who work with these clients are turning to TVD to maximize value delivery while minimizing cost and schedule overruns.

Target Value Delivery⁷ (TVD) is “the application of Target Costing (TC) to the delivery of projects in the Architecture-Engineering-Construction (AEC) industry. It is a method that makes customer constraints (on cost, time, location, and others) drivers for design in pursuit of value delivery (Tommelein and Ballard 2016). It is an application of Taiichi Ohno’s *Squeezing the wits* (Ohno, 2013, 104) and Toyota’s practice of self-imposing ‘no-compromise’ goals as a means for continual improvement (Liker 2004, 47-8).

Using TVD, product and production process design are developed concurrently with systematic value management and with continual reviews of the emerging cost. Cost is one of many constraints that designers must work with, rather than an output of the design process.

⁷ It was originally known as Target Value *Design*.

The main objective of TVD is to achieve the *holy grail* of construction management - to have reliable cost, schedule, and scope.

As Figure 12 indicates, design/TVD in IPD is concentrated much earlier in the overall process where the ability to influence cost and function are much higher and the cost of making changes much lower – these are the white lines in the figure. This enables a faster procurement timetable as shown in Figure 18 and enables a different way of thinking about both the design process and the construction process.

Set-based Concurrent Engineering

One of the key changes in the design process is the adoption of Set-based Concurrent Engineering (SBCE) (Figure 31). For many in construction, SBCE is very counterintuitive. It is difficult to believe that getting several specialist teams (clusters) working in parallel, studying a set of specific design options for different elements of a facility **and** delaying decisions will create a faster design process. Yet that is what happens. Designers gradually narrow these sets by eliminating inferior alternatives until they come to a final solution.

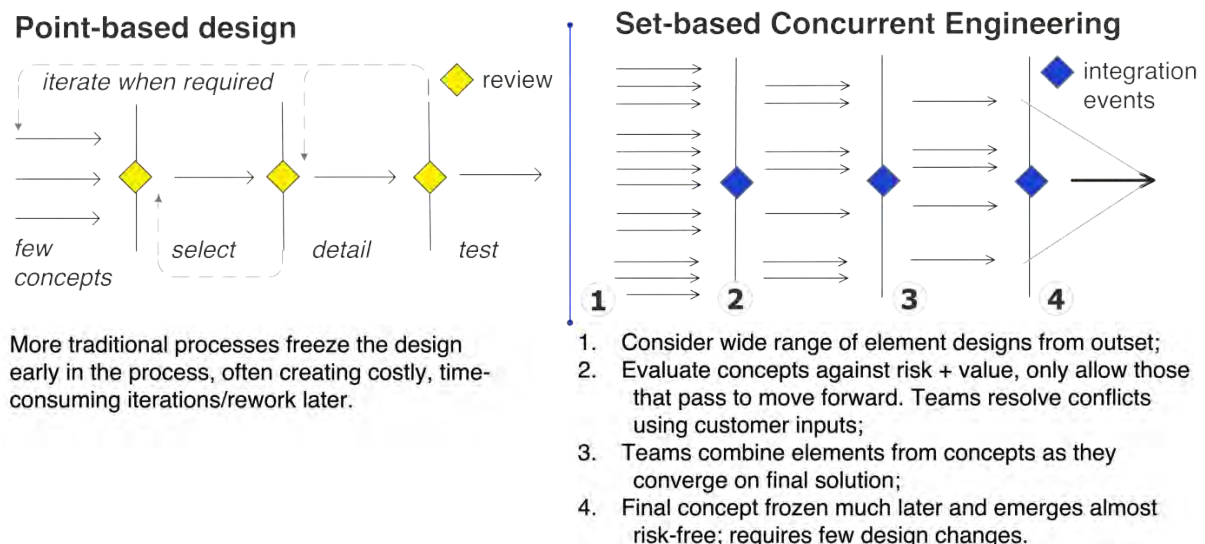


Figure 31: Traditional point-based and set-based design. after: Kennedy 2003.

Toyota were the first to deploy a coherent, company-wide, set-based philosophy (Ward et al 1995). SBCE encourages Value Management/Value Engineering right at the start of the design process where it was always meant to be done.

As Morgan and Liker (2006, 41-2) note, SBCE helps to front-load (left-shift) the design process to allow a thorough exploration of alternative design ideas. This solves problems at a root cause level early in the process and helps reduce late design changes that “are expensive, suboptimal, and always degrade both product and process performance.”

Collocation (7.13) makes SBCE much easier to manage.

At design stage on an IPD project each element (subsystem of the facility or set) is explored by a cluster group. The slide in Figure 32 from a 2005 Sutter presentation shows a typical set of clusters on a medical office project. Each cluster brings together relevant design and constructor members from the project team. Some people will be members of more than one cluster. The photo on the right, from a 2006 Sutter presentation, shows MEP detailers at work together with shared resources such as shared server, plotter, printer. Collocation and the shared server means they can coordinate while modelling (= clash avoidance). Technology has moved on considerably since 2006!

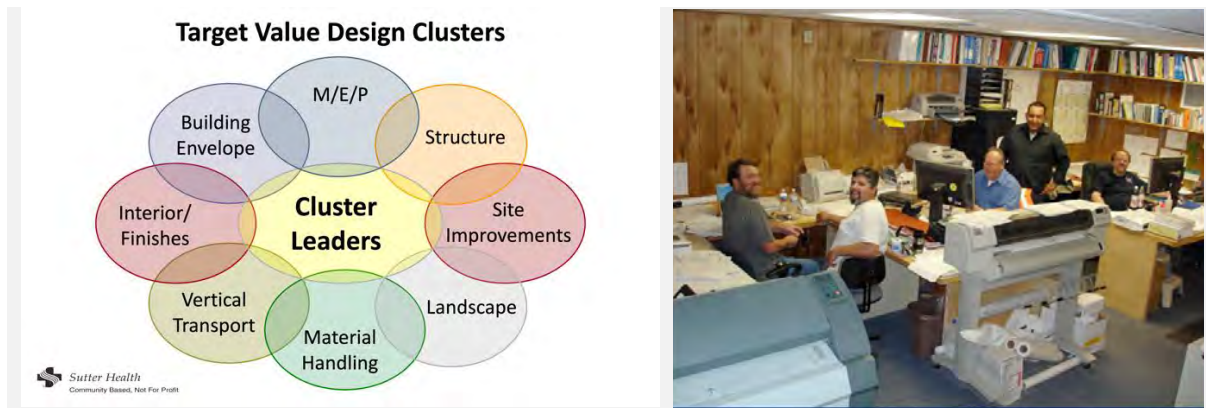


Figure 32: Left: An example of the Cluster Groups on a hospital project Right: a cluster at work.

The tension between what the client can afford and what the client wants in the way of scope, stimulates the creativity of the project team. The presence of constructors at the design table and their roles in **conceptually estimating** the likely outturn cost every 2 to 4 weeks as the design emerges is vital to the process. The lead constructor has skin in the game, so they have little or no interest in trying to fudge their estimates.

The manager's job is to prevent decisions from being made too quickly ... but once a decision is made, we change it only if absolutely necessary.
Morgan and Liker 2006.

TVD is a process and a culture that delivers a project within the collaboratively defined goals of the team. These goals are defined at the start of the project and used to guide the team to a successful conclusion. The goals may be backed up with a handful of KPIs. Understanding of the client's needs and goals is widely shared because delivery partners are involved in making them explicit during the *validation* process. This helps to set the tone and expectations for the project team. They typically cover (Martin 2012):

- Key design criteria and elements
- The target cost – budget that matches business case
- Required quality &/or value
- Schedule

During the delivery process it is inevitable that the unexpected will confront the team. Three TVD principles can help the team navigate these situations (Martin 2012):

- **The Cardinal Rule:** The total Target Cost of the facility must not be exceeded.
- **The Corresponding Rule:** Client satisfaction with the result (value) is equally important.
- **The Fundamental Challenge:** Anything unnecessary to the delivery of value is waste.

TVD works hand in hand with the other IPD processes including:

- The Last Planner System
- Choosing By Advantages
- A3 Reports

7.16. The Last Planner System of Production Control (LPS)

Reliability of work being carried out as planned is about 50% for *normal* construction and 40% for design. We know that every 1% increase in reliability (PPC) correlates to a 0.8% improvement

in productivity. A proper implementation of the Last Planner System in design & construction is a key and essential tool for IPD success. For more info see Ballard and Tommelein 2016 and 2021.

Takt production planning works well with LPS to help design and construction production flow to match the required work rate or “pulse”. In IPD/TVD the Takt Plan is developed as part of the design process by the lead constructor and key trades.

7.17. Choosing by Advantages (CBA)

One of the key features of a properly functioning IPD process is that good decisions are made quickly with consensus as close to where the work get done as possible, during both design and construction. Good decisions matter because they lead to effective actions that produce desired results. That’s why the method you use to make decisions matters.

sound sound effective desired
methods → decisions → actions → outcomes

CBA was used successfully on the NH Lower Thames Crossing project during the design phase.

Developed by Civil Engineer, Jim Suhr, CBA enables decision-makers to concentrate on what is important: the advantages (beneficial differences) that each alternative could deliver to stakeholders and basing the decision on the total importance of those advantages. By focusing on advantages for the customer/end user of the project CBA connects decision makers with their customers’ ideas about what they want. Involving constructors ensures that constructability is considered. Figure X shows an A3 report on a CBA managed decision process.

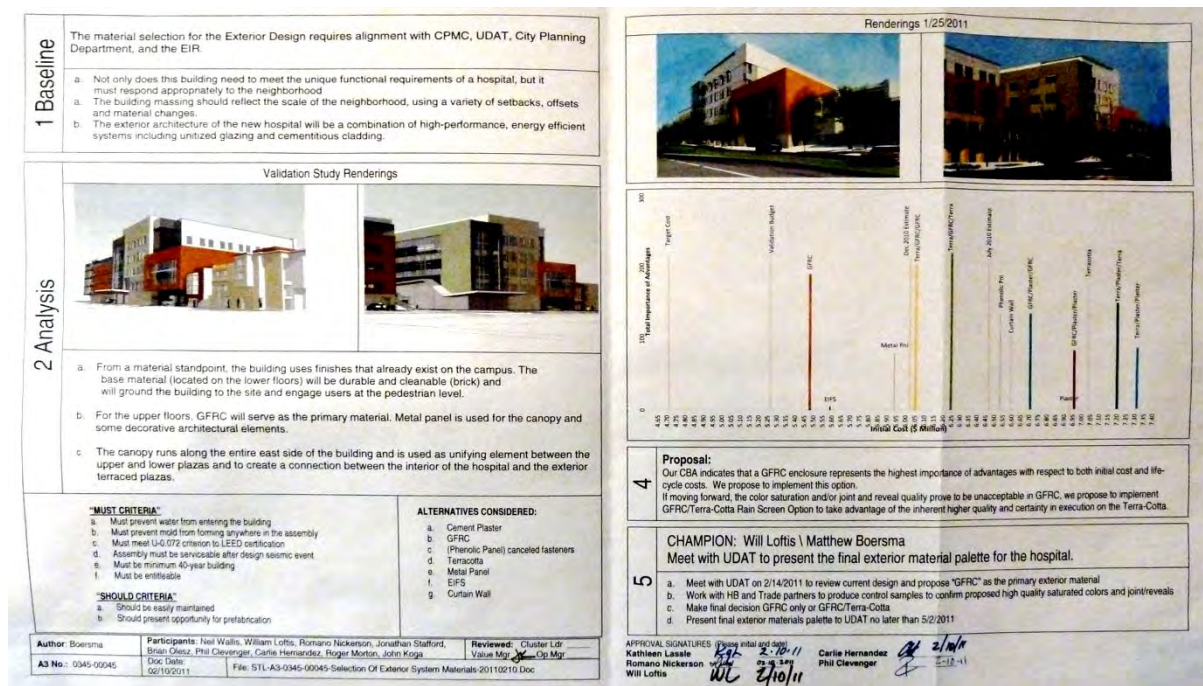


Figure 33: A3 report on a decision made using CBA about the choice of facade on a Sutter/CPMC St Luke's Hospital, San Francisco 2011 (photo: Mossman)

Suhr describes CBA as follows:

“Decades of research — sponsored by the U.S. Forest Service, in cooperation with Utah State University — led to the discovery that sound methods of decision-making do not base decisions on the importance of factors, criteria, goals, roles, objectives, categories, attributes, advantages

and disadvantages, or pros and cons. Instead, sound methods base decisions on the importance of advantages. To help people remember this principle, "Choosing By Advantages" is the name we selected for the set of decision-making concepts and methods that are being taught by the Institute for Decision Innovations, Inc. Other names that could have been selected include "Making Choices Correctly and Peacefully" and "Facts-Based Decision-making."

The CBA system replaces the collection of non-system methods that are used today – where, in many cases, each method has its own set of definitions, its own models of the decision-making process, and its own set of principles.

In contrast, the CBA system includes a wide variety of decision-making tools, techniques, and methods that are unified by just one set of definitions, models, and principles. The principles are central. The definitions and models help us to explain the principles; the methods enable us to apply the principles.

Because CBA is a system, it simplifies and clarifies the art of decision-making. And because the CBA methods are the sound methods, they produce better decisions – sometimes, much better." (<https://www.decisioninnovations.com/>)

Widely used in the US, as well as on the NH Lower Thames Crossing project, the CBA decision-making system includes a variety of decision-making tools and methods that are unified by just one set of definitions, models, and principles. For more information see **Snelling 2022**.

IPD projects commonly use the CBA decision-making system. Making good and effective decisions will have a profound impact on any project.

7.18. A3 Reports

In an IPD project, A3 reports are widely used to facilitate the exchange of ideas and information, leading to more informed decision making, and have helped develop a shared understanding within delivery teams. In dynamic projects, A3s help *on-board* new participants with information about the nature and status of the project. They can also introduce people on other projects to what has already been thought through and provide points of contact for further information on the subject. commonly used in conjunction with CBA. These provide simple output records of how decisions were made with each decision summarised on a single side of A3. Figure 34 shows a schematic for an A3 problem solving report.

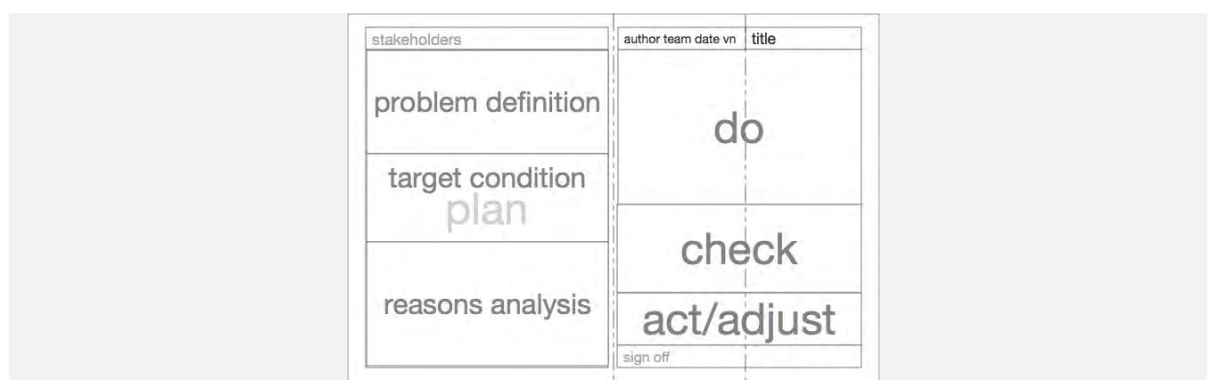


Figure 34: schematic for an A3 problem solving report.

On many projects A3s are posted on corridor or other walls in the Big Room so that the ideas, thinking and decisions are available to everyone. This is part of IPD visual information.



Figure 35: A3s on a corridor wall in a big room

7.19. BIM and other technologies

A common BIM platform helps to integrate the activities of delivery partners during both the design and the assembly processes. It can also act as a focus for integrating data from many sources and from other technologies.

This will help develop everyone's understanding of the totality of the project and enable people to see where fellow team members I've got to so that all the delivery partners are able to keep in step as the design process moves forward and then as the assembly process proceeds.

Having good information shared with the whole team enables team members to both identify problems and make better decisions faster.

This is another example of visual information in an IPD project.

7.20. IPLs: The client's representative on an IPD project

Now you are more a coach or a team leader whose task is to make sure that everybody has all the right possibilities and at the same time keep the overview of the project.

This section focuses on the skills required of good client reps — we call them *Integrated Project Leaders* (IPL). Delivery partners, particularly those with a seat on the Core team, require a very similar skill set in addition to their specific technical skills. This can allow leadership to rotate as the project moves from stage to stage and to holidays and illness.

Construction is a *people business*. Even with the digitalisation and automation of construction processes, the construction sector will remain a people business for many years to come. Senior leaders on collaborative and integrated projects require a wide range of both technical and people skills and understanding.

IPD is a system change for capital construction projects. The role of the client's representative is key to making this change successful (Knapp et al 2014). The skills IPLs need to deliver this change are legion. Individuals able to do most of them are few.

In 2015, Bill Seed, then Construction Director for the largest USA healthcare provider, UHS, reported that a traditionally trained project manager was “ill-equipped to deal with the relationship-based nature of IPD.” In addition to the traditional PM skills – finance, risk, task delegation, negotiation and legal awareness – an IPL must have a strong and diverse portfolio of leadership skills and be able to function in differing organisational structures and settings as the project progresses.

IPD projects have failed due to the Client's Rep being either not strong enough, not getting the support of the rest of the client's team or not understanding key tools such as Last Planner, Choosing by Advantages, Target Value Design (Knapp et al 2014). Several authors, including Seed, have listed skills and knowledge required by IPLs. Table 6 summarises lists from Bryson 2010, Knapp et al 2014, Mossman 2015, Seed 2014, 2022, and Walker and Lloyd-Walker 2015.

IPD requires a shift from command-and-control style leadership to coaching as it is more difficult to apply pressure on a delivery partner than a traditional sub-contractor. This was emphasised in a discussion one of the authors had with a former Sutter client representative and IPL about the selection of project leaders in one of the largest construction companies in the US. It was clear to this individual that project leaders with good people skills were much more effective than those without, yet the company did not select individuals with good people skills as project leaders.

ConsensusDocs300, a USA relational contract derived from the IFOA, states “*The Owner's [client's] authorized Core Group representative [the IPL] is _____, who shall be fully acquainted with the Project, and shall have authority to bind the Owner in all matters requiring the Owner's approval, authorization or written notice.*” This is very similar to the description for the other members of the Core Group. The IFOA, another relational contract, requires “*The meetings of the Core Group shall be facilitated by the Owner's Representative.*” As Knapp et al (2014) note this facilitation is done “as an equal”

In UK, the Client Representative on the Core Team (i.e. IPL) is likely to be an experienced construction designer, engineer or manager (though one of Sutter's early IPD client representatives was a political science grad with extensive construction experience).

Knapp et al (2014) provide examples of changes in a client rep's daily routine:

- **Design the project as a “network of commitments”** (remember the 5 Big Ideas). Make sure the team understands what a reliable promise⁸ is – make reliable promises yourself. Confirm that the person who commits to you understands that you require a reliable promise – expect no less.
- **Go and see for yourself** as the Toyota people would say or just walk around, be part of the action, don't discuss issues in the office – go to the design floor or work face to understand the issues or problems.

⁸ Reliable promises were originally described by Dr Fernando Flores. There is an excellent summary in Flores 2012.

Table 6: List of desirable Skills, Knowledge, Understanding & Appreciations (SKUA)

<u>some knowledge, appreciation & understanding of:</u>	<u>some knowledge, appreciation & understanding of, and skills (competence) in:</u>
<ul style="list-style-type: none"> • BIM + BIM Levels of Development • big rooms/collocation • construction & design • culture • emotional intelligence • IPD contracts • IPD project governance • Last Planner® use in design + assembly • lean project delivery • lean thinking and flow • learning & theory of knowledge • pre-fabrication • process improvement • production theory • psychology + psychological safety • Set-Based Design/Concurrent Engineering • systems • Target Value Delivery (TVD) • team building at a variety of levels • Training within Industry (TWI) • trust building • Variation 	<ul style="list-style-type: none"> • A3 preparation and reporting • being tough when it is important to the team's success (Bryson 2010, 127) • building and preserving relationships. (Bryson 2010, 129) • building trust between individuals and teams • Choosing By Advantages (CBA) • coaching individuals and teams • coordinating inputs from client departments • creating psychological safety across the project • cultivating and maintaining a web of relationships • defining decisions and facilitating decision-making using CBA with all relevant stakeholders • developing leaders across the project • eliciting opinions and information from stakeholders • enable decisions to be made as close to the information as possible (Marquet 2012) • encourage and facilitate process improvement • encouraging personal & team learning • encouraging reliable promising • ensuring people have what they need to do their jobs (Bryson 2010, 131) • facilitating <i>cluster</i> teams and meetings • facilitating the Core Team • fostering a learning culture • leadership, esp. servant leadership • looking at things from other people's points of view • making decisions on behalf of the client • managing in a networked organisation • managing boundaries • managing change • managing moods on the project • on-boarding individuals and teams • personal and organizational learning • process mapping • production planning & management • running simulations • serving the <i>value creators</i> on the project • sharing project metrics openly – even <i>bad</i> ones • supporting and challenging conceptual estimates • supporting the networks of commitments • systems integration • the need to be tough sometimes • training & instructing • working transparently

The phrase “*some knowledge, appreciation and understanding ...*” in Table 6 is used in the sense that “*one need not be eminent in any nor in all the parts in order to understand and apply it.*” (Deming, 1994, 93 referring to the System of Profound Knowledge). Walker and Lloyd-Walker (2015) talk about these collectively as KSAEs – knowledge, skills, attributes and experience.

- **Display the project's successes.** Have posters on the wall with metrics demonstrating the speed of handling RFI's or submittals. Visually demonstrate all safety issues, show the number of days until the next critical target date, display the results of Target Value Design – remember Bryson's transparency value.
- **Require that continuous improvement** is on everyone's mind. Ask for and reward ideas for improvement. Make certain that improvements are recognized by all. Establish a group to make this even more visible.

We would add that a core leadership skill is to foster intrinsic motivation in the team by helping create a sense of achievement, a high performing team (Katzenbach and Smith 2015) and empowerment.

Seed sees overcoming the “*Five Dysfunctions of a Team*” (Lencioni 2002) as key to the success of the core team. The opposites of the five dysfunctions are leadership challenges for every IPL:

- build trust and overcome defensive behaviours.
- deal objectively with difficult issues – on the best interests of the project, avoiding artificial harmony.
- build commitment from team – insisting on reliable promising and avoiding ambiguity.
- seeks high standards and acceptance of responsibility by the team.
- focus the team on required results.

Addressing these correctly creates a properly functioning Core Group and “a highly sustainable leadership model, far less susceptible to personnel turnover.” In addition, it creates opportunities for personal growth, great friendships and outstanding performance (Seed 2014).

Table 4: changes that IPL must be able to deal with (source Seed 2014, 1452ff)

Transformational Changes	Strategic Changes	Tactical Changes
Hierarchical → Networked Organization	Early team involvement	Last Planner System
Individual Company Goals → Project Goals	Consensus decision making	A3 Thinking
Personal Goals → Project Goals	Seek and use craft, trade and multi-stakeholder input	Choosing by Advantages
Piece work optimization → project-wide improvement	Continuous estimating	PDCA Cycles
Local Optimization → value stream optimization	Target Value Design	Swarming
Rigidly defined roles → no stripes in the room	PDCA in all phases of development and build	5 Why
“Just get it done” → PDCA Cycles	Burn-rate management	Big Room Rules
“Just get it done” → continuous reflection	Consolidated budget/cost management	Daily huddles
	Conditions of Satisfaction	Conditions of Satisfaction

Nishizaki and Seed (2015) discuss the changing nature of the IPL role in three project delivery domains of Organisation, Commercial and Operating System (or management process). These three domains were further divided into pre-permit and post permit phases.

Table 4 outlines the types of change that an IPL must be able to recognise and facilitate when working in a Lean IPD Project (Seed 2014).

Smith and Rybkowski (2012) explore the concept of trust and that project performance can be assisted by increased levels of trust. They state IPD as being built on collaboration which is in turn built on trust. This backs up Seeds recommendations (Seed 2014) in terms of a core skill of an IPL is to actively build trust.

Participants in a study of personality traits of IPLs in the USA by Nishizaki and Seed (2015) noted it is more difficult to apply pressure to a delivery partner than to a traditional subcontractor. This indicates that the IPL must be empathetic towards the needs of their fellow team members to reach a joint goal, rather than using a primarily directive style. Nishizaki and Seed's key finding was that "in a team environment, no one behavioral style is necessarily better than another, but when they are combined successfully, the end result can be optimized outcomes."

Nishizaki and Seed (2015) describe IPD in the USA as a *new and not widely accepted process*. That is even more true in the UK. That leaves IPLs open to political and emotional challenge by senior leaders who do not fully understand the purpose and processes of IPD. As Patterson et al. (2012) show there are ways of responding to those challenges, those "crucial conversations", that are not career limiting. It is important that IPLs are skilled in having crucial conversations — and not just with their own senior leaders; they also need to be able to have difficult conversations with delivery partners, suppliers and offers. Patterson et al's research points the way to that.

Nishizaki and Seed (2015) conclude that it will help IPLs to have:

- High emotional intelligence.
- Proficiency at cultivating and maintaining a web of relationships.
- Skill of sensing other people's emotions, understanding their perspective, and taking an active interest in their concerns
- Visioning and Coaching skills rather than using command & control

Seed, Long, Howell, Rybkowski, Smith and Bryson are all current or former construction professionals. Notice that each of them is putting the emphasis on people skills. If we want work to flow smoothly, we must find ways to eliminate the friction between people.

In a paper looking at the nature of co-located spaces in Sweden, Bosch-Sijtserma and Tjell (2017) quote a design project manager (our emphasis):

*"The qualification of a project manager is becoming more complex. Previously a project manager was a 'meeting athlete'. You would have a formal meeting, that you went through in a structured way, where you are drawing on all the threads yourself. **Now you are more a coach or a team leader whose task is to make sure that everybody has all the right possibilities and at the same time keep the overview of the project.** I see that as one of the biggest challenges, also here in my own group because it is not everybody who has the skills of being a coach, it is easier to take a step back and rely on all the formal steps. So that is a personal skill that has to be developed".*

7.21. Project as a learning organisation

One key role for an IPL is to promote learning on the project. There are several lean tools that can help this process. The IPL need to be familiar with and able to facilitate all of them. They range from the simple to the complex:

- Plus/Delta or do again/do better
- The Last Planner System
- Systematic process improvement

- Encouraging people to declare breakdowns, so that the breakdown can be fixed
- Asking people what they are working to improve
- Asking people what makes it difficult for them to do the work

Actions like these contribute to *everyday learning* and the creation of new habits that prevent the repetition of mistakes. As the new changed work practices are repeated day after day, week after week they become embedded in current good practice. In this way it is much easier to take the learning from this project through to future projects.

By comparison *lessons learned* sessions at the end of projects and sometimes part way through are of limited value when it is not safe to own up to errors and omissions that have not been revealed to other parties in the project. To do so is to invite a claim against yourself or your company.

Seed laments *mobility of management*, one of Deming's 7 *Deadly Diseases* (Deming 1982) as a key cause of lack of learning from project to project, caused by changes in team members, and slowing down the full potential of IPD.

7.22. Readings for IPLs

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