Optionality in Resource Mega Projects

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1. Objective

The intention of this paper is to highlight the need, and potential pathways for achieving Optionality in large resource development projects. We have deliberately drawn from examples across different industries, with the belief that this provides fertile input for "lean capital" approaches to achieving Optionality. This paper is not intended to be a full literature appraisal on the field or to act as a "how-to" resource, but will describe the elements of Optionality, its benefits and impacts.

Optionality enables a business to adapt to with minimum disruption, and profit from, future changes in: technology; resource utilisation; community imposed metrics and market competition. Creating Optionality is typically a proactive process of embedding complementary elements in the design, development, operation and sustainment of a business, but it can also arise through a more serendipitous chain of events.

The increasing "clock-speed" of external shifts is creating a pervasive management complexity that demands the flexibility and agility enabled by embedding Optionality across all major value chain components. Managers need to examine likely futures, and crafting their operating strategy and design to optimise and embrace potential external shifts.

2. Why should we be concerned with Optionality?

In answering this, one should initially reflect on several questions:

- What do I get if I achieve Optionality?
- What do I lose if I don't have Optionality?
- How does one identify where to embed Optionality?
- What does it take to embed Optionality?
- Can I do this given my organisation and culture?
- Given the world is increasing in complexity and risk, how will Optionality help?

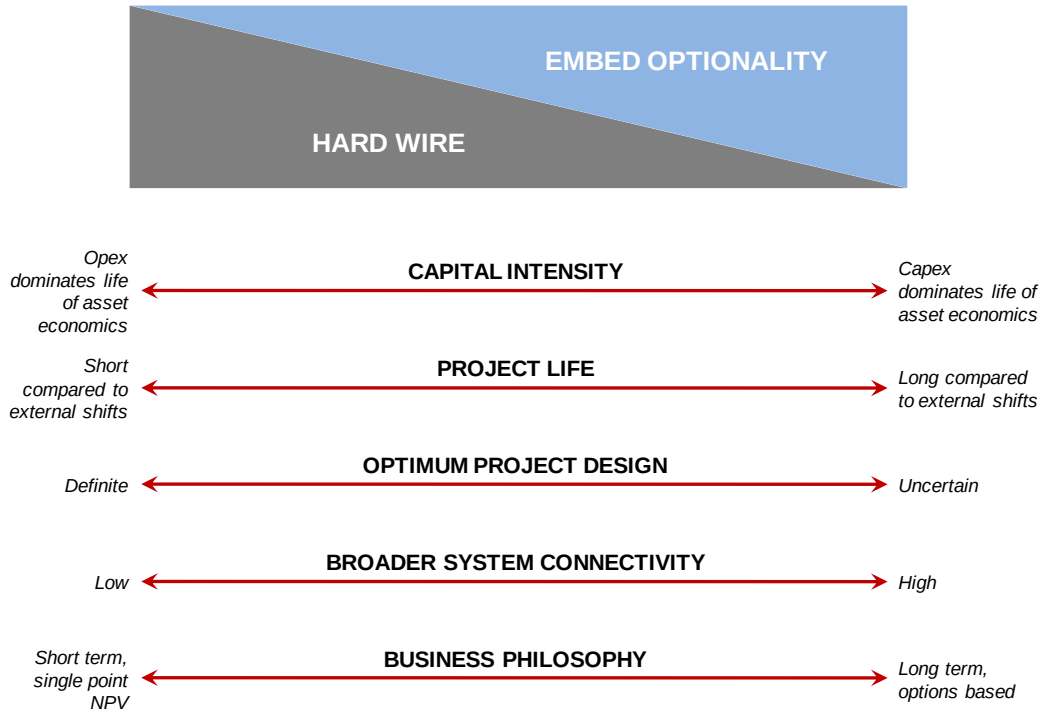
Use of Optionality becomes increasingly important in large resource development projects with attributes including:

- The quantum of early capital investment contributes a large proportion of the lifetime value proposition
- The project life is long compared with the "clock-speed" of external shifts that will change the economics of the project, in particular: sovereign risk and community expectations; market dynamics; and production technologies
- The initial optimum project design is uncertain, often driven by immature or legacy technologies, potentially obsolete economic assumptions, and rigid process tools certain to become limiting in the future
- The project must be linked to the broader production system, where integration is important, and where that broader system is likely to change as well
- The business model of the governing corporate, is one that seeks to derive value from leveraging uncertainty and the associated option value over the long term

See Figure 1 for more detail.

While this list is not exhaustive, most of these criteria support the case for aggressive consideration of Optionality in the development of Mega Projects.

Figure 1 When is Optionality Important?



Optionality is not free, nor easy. Even in the instance where the investment required for adding Optionality is relatively small, the effort to address and enact Optionality at the leadership level is complex, particularly compared with traditional hierarchical / deterministic models. The cost also increases when substantial change is required for an established culture which will not embrace Optionality without a compelling benefit they understand and are recognised for enabling.

When assessing the case for embedded Optionality it is worth reflecting on long standing wisdom:

"It is not the strongest of the species that survives, nor the most intelligent. It is the one that is the most adaptable to change." - Charles Darwin

More recently, circumstances have amended this wisdom to say:

"With the increasing level of complexity, shrinking time to research and plan responses, and long lasting consequences of major decisions, incorporating adaptation and agility is critical to extract greatest possible value both now and the future." - VCI

3. How do we make money from Optionality?

Evaluation of the case for embedded Optionality rests on answering the fundamental question: "how do we make money from Optionality that we will not get any other way?"

As with all money making ventures, the corollary to the opportunity also exists, and that is "how do we prevent losing money and opportunity due to lack of incorporation of Optionality in our plan and execution?"

In the case of large resource projects such, apparent major sources of option value could include:

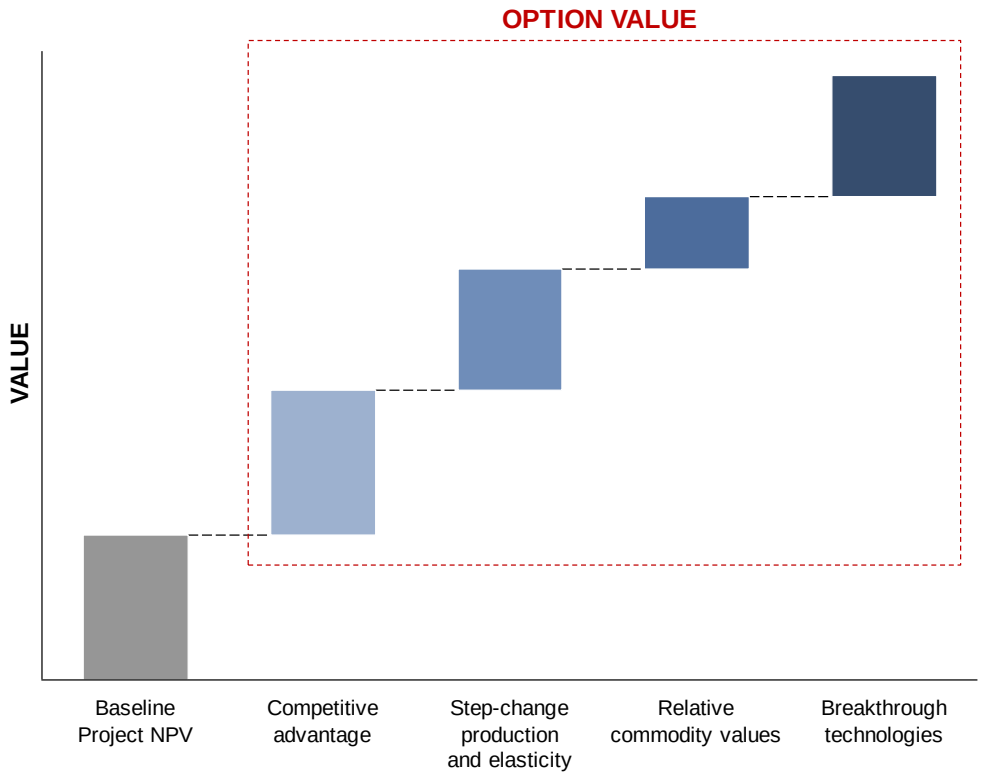
- Competitive advantage through acquisition or diminishment of competitors
    - For example, ownership of infrastructure options facilitating acquisition, or having the capacity to pre-emptively secure markets, locking out competitors
- Capacity for rapid step change production and incremental elasticity i.e. better, sooner, faster, and in either direction as needed
    - This is intrinsically linked with competitive advantage (above), but has substantive value in its own right through the ability to leverage unexpected demand and price upside
- Shifts in relative commodity values
    - Relative values of commodities will shift over time, providing value through adaptability in mine planning, process plant operation etc. This is particularly relevant for resources with a multi-product ore-body given the increased volatility in prices especially as emerging nations become major consumers as well as competitors
- Break-through technologies, particularly in respect of automation, extraction, process efficiencies and secondary operations that future mines may allow.
    - Over the long term, the potential for step change technologies in finding and extracting minerals remains significant.

The above list is by no means exhaustive, and the question of where option value may be secured warrants substantial investigation.

To maximize value from Optionality it is most appropriately viewed as an offensive, not a defensive posture. That is the mindset should be one of "examining all options for those that exhibit maximum value and realistic achievability. Because of the methods used to examine Optionality insertion in a given business, it is possible to consider a variety of approaches with no implementation risk until evidence-based decisions can be confirmed.

Finally, most sources of option value, including those listed, rest on the foundation of seeing / sensing the future earlier, and having the ability to act faster, than our industry competitors. That is, compression of lead times from sensing to acting is critical. The challenge is how to crystalize this option value with the minimum possible capital investment. Achieving this objective typically requires innovation.

Figure 2 Where Is The Potential Value From Optionality? (Illustrative)

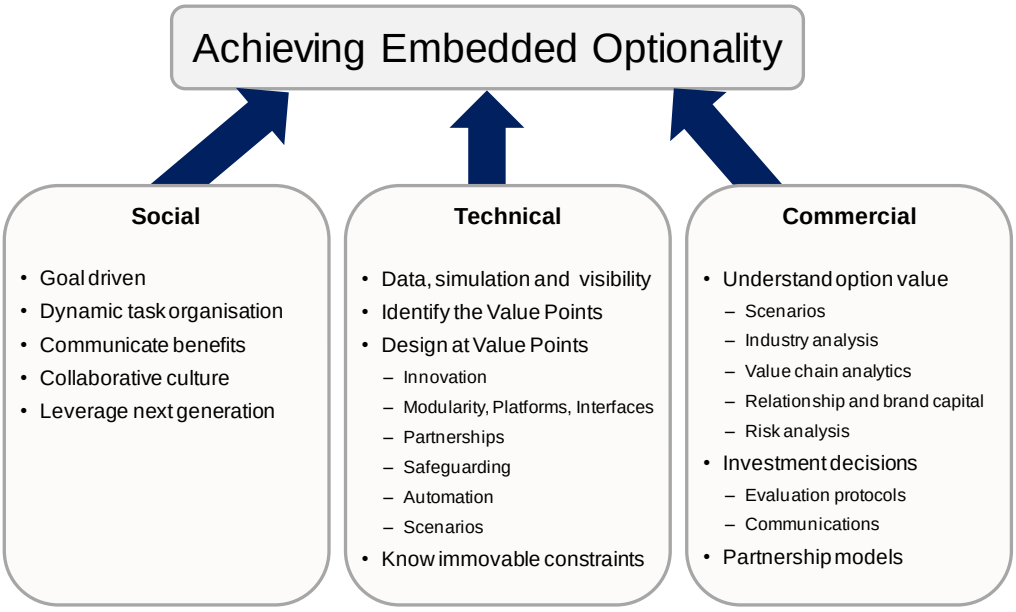


4. How can we achieve optionality?

Best practice tells us that for those who leverage the most value from Optionality, it is not an "add on", nor a "new skill set". It is embedded, and must become part of the "DNA" of the business. The mindset is not to embed Optionality because it is needed as a defense, but because the value is there and the business intends to pursue it aggressively.

Embedded Optionality is a function of the integrated social; technical and commercial dimensions of a business (see Figure 3). We have made no attempt at evaluating whether the technical precedes the social design, or vice versa, with the view that each of these elements are part of an integrated approach to Optionality. With the best technical design in the world, if people within the business are not actively aligned with the strategic intent, then they will either deliberately or inadvertently inhibit Optionality. Likewise with the best intent in the world, unless the "physics" of the system is supportive, then Optionality cannot be achieved, particularly in such large scale processes.

Figure 3 Achieving Embedded Optionality



4.1 The Social Dimension (Organisation and Culture)

Social attributes within the business which support embedded Optionality include:

- Strong goal based culture
    - A strong goal based culture (visa vi process bias), enables and incentivises rapid recognition of, and action on opportunities. This is the starting point for aggressively pursuing option value.
- Dynamic task based organisational structure
    - A task based organisation focussed on achievement of goals is necessary and will need to change dynamically as tasks requirements shift.
    - Strong static hierarchies and middle management entropy generally impede Optionality
- Collaborative culture, both internally and externally
    - Collaboration across boundaries shortens response time, and improves quality of response. It is a fundamental enabler of agility.
    - Collaboration with external partners is particularly important given the increasing segmentation of supply chains, and the alignment that will be required for agile response to opportunity.
- Make benefits and connectivity of system explicit
    - Operational units frequently bear the brunt of poorly designed approaches to Optionality, and therefore resist. The key is making connectivity of the broader system and their ownvalue contribution transparent. This ensures efforts in support of others that would otherwise be seen as overhead are seen as value adding.
- Leveraging the next generation workforce
    - Social and technology shifts mean that next generation are more predisposed to working in teams and presenting options. They are also less committed to past practices which impede agility

Fundamentally, the inherent culture must be more agile than the enterprise within which it contained, in order for option value to be seen, and adaption to capture this value pursued. This is corporate social agility.

Mega Projects inherently contain ground-breaking endeavours, whether at an industry level or simply new to the executing culture, that demand a combination of well communicated project awareness, clear responsibility mapping that is regularly revisited and confirmed, and inherent adjustability in coordinated tasking to adapt to discovered needs.

4.2 The Technical Dimension

Technical design and processes which support embedded Optionality, span the following domains:

Enabling Decisions:

- Data sensing and knowledge gathering
    - Effective data sensing is important to understand complex process interdependencies that underpin value assessments, and in decision making.
    - Data sensing processes should be flexible to evolve, on the basis of a range of parameters including: feedback from simulation, assessment of value leverage, evolving requirements of decision analysis etc.
- Simulation of the value chain (integrating technical, commercial, and behaviours)
    - Optionality is often rejected because its value cannot be interpreted or measured. Continuous parallel simulation is key to alleviating this constraint, as it enables the future to be fast forwarded under potentially limitless external scenarios.
    - The science of simulation is moving rapidly, and we are potentially at a tipping point in respect of its application. Early adopters such as the energy and electric utility communities as well as military logistics have been using this for nearly a decade with dramatic impact. Agent based modelling in particular is well suited to open systems, and incorporating both technical rules and behavioural motives.
- Providing continuous visibility of enterprise state
    - Seeing a clear picture of how processes are operating and interacting as currently managed, in parallel with a simulation that takes the input from real time monitoring, creates an environment that shows what an optimised set of decisions would have yielded and targets what needs to be adjusted to enable better results.
    - Making data, process and simulation visible creates the widest possible net for contribution to improvement, and promotes understanding of interconnectivity.

Identifying Value Leverage Points:

- Understanding where the greatest value generation lies in the process, in order to focus Optionality efforts
    - Frequently the real value leverage points are not high on the list of design for Optionality, innovation, and technical / systems development. This lack of recognition occurs for several reasons including that we overlook the fact that value points can be “virtual”, with the elements not physically co-located (refer: “Automobile Manufacture” and “”London Ring” in Cases). Value points are also likely to be systems as well as physical processes

- The science of understanding value generation points has advanced substantially in recent years, particularly in the fields of electronics and manufacturing, where margins are tight, and the parameters required for optimisation are large, and they change frequently.

Embedding Optionality at Value Leverage Points:

- Innovation
  - At high value points it is important to position the enterprise to take advantage of external innovation and technology developments, and where necessary drive direct innovation according to needs
  - Innovation will be particularly valuable where response times can be imploded, and agility increased. It is also an essential ingredient to "lean" Optionality, that is, restricting the "path of least resistance" tendency to use inefficiently applied capital to preserve Optionality
- Modularity, Platform and Interface design
  - To facilitate rapid change out as technology evolves, design of the modular and platform boundaries, along with interface mechanisms with the broader system is important
  - Modularity and platform design also plays an important part in enabling innovation, through enablement of the broader business ecosystem to access opportunity
- Partnerships
  - Given the segmentation in the value chain, partnership relationships and alignment is a key factor in agile response to option value, and in innovation. This is both a cultural, commercial and technical challenge.
- Safeguarding
  - Once value points are known, additional capacity can be pre-emptively installed, at potentially lower cost, to enable rapid response to option value
  - Safe-guarding can either be active, where capacity is installed "up-front", or passive, where the option for capacity installation is preserved.
- Automation
  - Full automation can deliver Optionality, in that change management complexity is inherently reduced. Also, processes are also likely to be more elastic, and potentially operated closer to technical limits.
  - Automation also promotes a data rich environment, which enables greater visibility in value based decision making, and therefore assessment of option value
- Scenarios
  - Predicting technology evolution beyond 10 to 15 years is at best problematic. For long life projects, technology scenario planning at critical value points is a useful tool in understanding how technology may evolve, and therefore positioning to encourage appropriate development and exploit it.
  - This is not static scenario planning but rather scenario discovery and testing that is very dynamic.

Understand Immovable Constraints

- Understanding where Optionality is not possible

- This is an insight in sight, which in itself generates substantial value. It helps focus resources in subordination to constraints that cannot be changed, and avoids expending effort on changing the unchangeable.

4.3 The Commercial Dimension

The Commercial Dimension that supports Optionality rests on a few important factors:

Understanding Option Value

- External Scenarios
  - Arguably the largest potential option value in the resource industry is shaped by the broad external scenarios, and the ability to recognise opportunity early, and act more rapidly than competitors.
- Dynamic Industry Analysis (Gaming)
  - The probability of realising option value will be shaped by competitive dynamics and response to strategies implemented. Understanding the competitive dynamics, and how the game unfolds, is therefore an essential element in quantifying option value (= probability x potential)
- Value chain analytics and simulation
  - Combining technical and commercial parameters in simulation along the value chain is a foundation for valuing Optionality
  - However, simulation systems in the resource industry are typically technically biased, without commercial parameters being fully integrated and embedded. This situation is changing rapidly with developments in computing power, analytics, and global supply chain management across industries
- Valuing relationships and brand
  - Brand and relationship capital feature heavily in the exercising of options. This is particularly the case when political or community consent is required. Applying a commercial assessment of this potential will enable investment decision making where capability or capital is needed to be deployed to preserve options.
- Risk assessment
  - Gaining a better understanding of the benefits of embedded Optionality and the opportunity costs of ignoring it is key
  - A shift away from a complete reliance on single point NPV analysis is a step in the right direction, with Real Options Analysis and other methodologies increasingly used to support investment decision making

Making Investment Decisions

- Evaluation protocols must be redesigned to give weight to option value and enable associated investments in embedded Optionality
  - This is embryonic in implementation, but real in fact. For example, the for-gone value in slow expansion in the bulk minerals industries in Australia in response to China growth has run into the tens of billions of dollars

    - Executives and other decision makers need clarity around potential returns and risks, and must be able to make a like-for-like comparison between investing in Optionality and forgoing it
- Communications strategies need to be refined, both internally and externally to build support for investments in embedded Optionality, particulars where payoffs are uncertain and/ or won't be realised in the near-term
    - It is important that the communication processes make the concept of option value and its assessment far more accessible. Option value is frequently omitted from consideration because of the perception of mathematical complexity, whereas in reality it is a very practical concept that we all apply in our own lives, every day.

Designing Partnership Models

- Commercial relationships with supply chain partners, that facilitate exploitation of Optionality
    - Master slave relationships, are a deep impediment to achieving Optionality

5. Cases

Computer Componentry - *Modularity, Platforms, Interface Design, Partnerships, …*

Computers are developed in a modular fashion, with the typical modules of: power supply unit, processors, mainboards, graphics cards, hard drives, optical drives, etc. All of these parts are easily interchangeable, using parts that support the same standard interface.

This provides the option of upgrading of specific elements as technology advances or as demanded by the user without having to replace the whole system. It also promotes innovation through modular specialisation, and cost competition through accessibility of platform elements.

Automobile Manufacture - *Platforms, Modularity Partnerships, Parallel Design and Construction, …*

The Automobile platform strategy leverages a small set of common car platforms with standardised interfaces, from which a large number of car styles are then built from. Platforms allow manufacturers to sharply reduce product development and changeover times, therefore better meeting changing consumer demand. This is driven by:

- A reduction in the amount of design and research required to deliver a new model
- Enables greater productivity from factories globally due to standardisation

The standardisation of interfaces has also allowed the automobile industry to leverage collaboration with partners and suppliers in car manufacturing. These relationships allow orginal Equipment Manufacturers (OEMs) to greatly speed up the product development times and increase the level of innovation across specific areas.

Heathrow Airport Terminal 5 Expansion - *Active and Passive Safe Guarding, Modularity and Scenarios*

The expansion of Heathrow Airport was designed in two phases / stages. The first phase would include two terminal buildings and a car park, whereas the second phase would include a third terminal building. The decision was made to spend an extra €150 million to design and build the foundations for the third terminal building concurrently with the design and physical execution of the other two terminal buildings and ancillary facilities.

Spending the extra €150 million in active safeguarding, reduced, the cost of exercising the option of phase 2 by six times

The Heathrow Terminal 5 expansion involved the construction of an underground train tunnel. This tunnel included the provision for two extra platforms in modular formation (unneeded at the present), safeguarding the extension of an additional train line to the Heathrow airport in the future.

This costly upfront investment provides the option to build an extra train line in the future, which is not constrained to the current train designs.

Bridge over the River Tagus, Lisbon - *Active Safeguarding, and Scenarios*

A major toll suspension bridge in Lisbon, Portugal, was engineered and built in the sixties with an ultimate design of adding two more lanes to increase capacity from four to six lanes for car traffic; and add two railway tracks. The option was enabled via designing and building upfront, the main structural reinforcements (overhead suspension cables, foundations and towers) that could support the design loads of the expanded scenario.

This allowed both options to be exercised to plan almost thirty years after the bridge opened to the public in 1964 once demand for additional car traffic and passenger railway finally materialized.

Dual input combined cycle electricity generation plants - *Active Safeguarding*

Combined cycle electricity generation plants are designed and built to burn both oil and natural gas.

The operating cost of inputs over the life of the plant is much greater than the capital costs of building in the Optionality. Therefore given the volatility of input prices, giving the operator the option to switch between fuels provides high levels of value.

Australian Submarine Design and Construction - *Modularity, Partnerships, Scenarios …*

Large defence construction projects such as submarine construction are arguably some of the most complex projects delivered globally. Their complexity stems from the long time frame from design to implementation (~20 years or more), the rapidly developing associated technologies, parallel global design and construction, broad range of integrated contractors, and the range of organisation cultures involved (defence, construction, manufacturing, research, …).

Submarine constructers heavily use internal modularity to allow parallel construction of hull and internal elements. This also facilitates Optionality as technology changes, particularly in refits. These businesses are also very effective exponents of partnership management given the vast number of suppliers, each of which are performing at the edge of proven technology.

One area where, perhaps improvements through embedded Optionality techniques could be leveraged further is in scenario planning in respect of fast moving technologies. For example, in one example, the life of design and construction project spanned the evolution of several generations of weapons systems due to developments in information technology. In this instance, more than one system was designed and decommissioned prior to the first boat being launched.

MERCK HIV Wonder Drug Manufacturing Facility - *Process Flexibility, Lead Time Compression, Partnerships …*

In response to the global AIDS epidemic, Merck developed an effective mitigation cocktail but needed to get to market several times faster than any similar plant in their history.

Their response consisted of implementation of a dedicated engineering group, and instead of fast tracking the construction or refit of one dedicated plant, they redesigned their own and all of their vendor/supplier/subcontractor/operations processes in a way that could be used in all fast tracking time to market for all future pharma facilities in Merck.

The overall impact was that the plant was originally scheduled to take 36 months to complete and after systemic Mega Project thinking, was done in 13 months. Getting the plant online almost two years early was worth $320 million increase in revenue in first year and almost $2 billion by time plant was originally supposed to just be opened.

Verizon, Sprint and AT&T 3G Infrastructure Build-out - *Lead Time Compression, Partnerships, …*

The consortia needed to building thousands of cell stations nation-wide in a fourth the time of any prior effort to position AT&T for IPhone impacts. The project involved many wireless providers, major engineering firms, and hundreds of local and regional contractors all using different methods and systems.

The effort was completed well before actual handset distribution was ready and overall system engineered to be ready for 4G and 5G with only one cabinet switch out. Contributing companies were able to absorb massive popularity of smart phone, iPhone products and be ready for new cell systems coming next. This project increased wireless revenues over $7 billion in first year.

London Ring - Giant fresh water distribution re-invention throughout London - *Partnerships, Simulation, Innovation, …*

Almost 50% of all water treated for human consumption was being lost to leakage before ever reaching a customer. A project consortium consisting of four major publically traded water companies and hundreds of subcontractors were commissioned to design, rip-out, install, test and optimize a multi-billion dollar investment. In particular disruption of this essential utility was limited

Distinguishing results included delivery of the project on schedule, at a cost below that predicted using conventional bonding techniques, leakage reduced to under 3%, lowered pumping costs by nearly half, improved safety for fire emergency response and nearly eliminated water-borne disease infusion into the system from soils surrounding leak zones.

6. Conclusion

Megaproject developments fit all of the criteria that indicate that embedded Optionality will be a core component of the business value equation. The capital intensity is massive, the life is multi-generational, and social, economic and technical developments are moving fast.

It should be recognised that embedding Optionality is a social as well as a technical design challenge. Some of the key levers and insights have been discussed in this paper, but as with any integrated design process, careful and insightful consideration is necessary.

A critical attribute in the design will be the ability to achieve agility, and compress response times, without over-investing in capital as the solution (a likely temptation). In this endeavour innovation will be key. In the innovation challenge, and in achieving agility, the approach to partnerships will also be fundamental given the multi-faceted nature of the value chain.

Finally, understanding option value and being able to communicate it in an accessible manner with visceral impact will be a pre-requisite for success. There have been some false starts in this respect, within the industry, and with option value being viewed with scepticism by some. It will be important to think differently about this communication challenge rather than necessarily seeking to improve previous approaches.

7. To Learn More

To learn more about how Optionality could transform your organisation, please contact any one of the following VCI Global Partners:

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