Delivering Place-based Infrastructure and Land Use Planning using Digital Twins

Jason Natoli (Director)
Integran Infrastructure Management & Outvye Technologies Pty Ltd

Abstract:
Managing population growth throughout Australia is a key matter of public policy, evident in the reform process underway and the political messaging of the major parties. Planning for housing, jobs and infrastructure has been particularly challenging in the last 10 years and even more so as supply fails to meet demand resulting in rising costs and affordability issues. The complexity of aligned and pragmatic infrastructure planning is exacerbated by an absence of collaborative processes and the tools needed to plan across multiple service providers and jurisdictions. The current approach to planning is generally siloed within an agency or asset class given these barriers. Therefore, the delivery of necessary infrastructure has in some cases failed to meet demands of communities primarily from lack of funding to provide for the necessary investments.

New approaches and tools are required to support the ability to collaborate in a meaningful, systemised and quantified way, allowing rapid assessment of new information, infrastructure and/or changing demands and to test alternative growth scenarios. This is important to optimise delivery and deliver better value for money.

There is a clear need for decision making to be driven by a strong evidence base, shared within the collaborative process to close the gaps in infrastructure service delivery to the places in which we live. A place-based planning process is one built on collaboration across asset classes, defining the standards and levels of service (e.g. greenspace, education, transport, utilities and services) and working methodically to deliver an outcome which ultimately delivers a ‘place’ in which people feel connected, comfortable, empowered and contented. Ultimately this ensures the willingness to pay is aligned to delivery.

The reforms in this area are driving for solutions using innovative technology such as Digital Twins like Outvye®. This platform provides a systemised solution to these challenges, allowing organisations to collaborate and strategically plan, analyse and prioritise investment by emulating the planning, infrastructure management and financial decision-making process. Importantly this has been built to meet the needs of changing national and state policy but also standards such as ISO and those developed by the IPWEA.

Keywords: Place-based, strategic, digital twin, planning, infrastructure
Preface

The challenges facing our communities are growing from economic, geopolitical, environmental and rapid technology change. If change is to be constant where can we find some form of certainty in the way in which we obtain information, process it and make decisions which the community has established a level of ‘buy-in’. COAG met in early October 2019 to work through their latest efforts to better address population and growth challenges including how to service the communities with much needed infrastructure.

In the age of Smart Cities is equal effort being delivered in the ‘smart’ management of our regions, towns, remote areas and cities and how can we do better?

This question has been part of an ongoing conversation for over a decade that has surfaced in various reform papers and agendas within the various states and territories and at the federal level. The management of population growth, land use and infrastructure including its planning, design, funding and delivery is fundamental to getting smarter management of the places in which we live, work and play, but how is this achieved?

Analysis of the last decade of reforms and my own experience over two decades have demonstrated that key to progressing these goals can be distilled into 6 key themes, being:

1. Governance
2. Data and Evidence Base
3. Collaboration
4. Innovative Technology
5. Strategic Thinking
6. Smart Investment

While each of these themes is worthy of a paper in it own right, this paper focuses on:

- Theme 3 – Place Base Planning and Collaboration; and
- Theme 4 - Innovative Technology.

Place-based Planning and Collaboration

Given the complex and varied sources of change cover a wide range of professional areas and circumstances it is paramount that as much reconnaissance and intel that can be brought to bear in decision making.

An approach to ensure organisations, and indeed government as a whole, can deal with these matters is known as ‘place-based’ planning. It is potentially a different take on current practice but importantly it seeks to establish a new paradigm in the way planning our regions, local governments, towns and cities is undertaken and how all levels of government, industry and the community come together to make decisions.
Importantly place-based panning can operate at any level of detail, and in our assessment, should be at the following ‘place’ scales which provides increasing focus in a structured context:

- defined economic regions (e.g. 11 Qld Regions),
- local government area (77 LGA’s in QLD),
- planning areas (major growth corridor/area, neighbourhoods, catchment, etc) and
- precinct level (key activity node, main town centre, tourist area, etc).

I like to describe Place based planning as:

“A holistic investigation of a defined ‘place’, its community, land use and infrastructure creating a solid evidence base around which a collaborative process of options development ultimately establishes an agreed strategic vision capable of delivering the social, environmental and economic needs of the community in a sustainable manner.”

How is this possible given the scale of involvement and how could consensus be achieved?

Importantly this process already exists to some extent in Regional Plans, Planning Schemes, Local Government Infrastructure Plans, Master Plans and Local Area Plans, however, how can we make this more systemised, incorporated into our day to day activities so we have the benefit of combined ‘up to date’ knowledge without lengthy consultation. Also, how can we use this data to quickly assess the changes and challenges that are put before us.

Part of the answer lies in collaboration that can only be effective if there is a governance framework that ensures all participants understand their roles and responsibilities and importantly can share data and insights in a consistent and trusted manner. This includes a schedule of curated collaboration events (e.g. Regional-quadrennial, LGA- biennial), with relevant stakeholders where the participants to come together, review and share information, gain insight, think strategically problem solve and achieve outcomes.

Fundamentally this will be effective only when a reliable standardised evidence base which is well managed can be used prior, during and after the collaboration event to become informed, make better sense of the issues and ultimately make decisions that will drive at the agreed strategic vision. In this way participants can be informed or relevant information from another organisation.

For example:

- Council road and transport officers review DTMR’s latest forward capital plan, projects in planning and concepts beyond 10 years to inform and influence their own plans or to highlight issues in decisions or directions of DTMR and vice versa.
- Education’s school planners reviewing the latest growth corridor planning, applications, approvals and lot production from Council in a consistent data set across Qld.

A key benefit of this process is to properly assess rapidly alternative options to key challenges such as mobility, housing density or timely and coordinated infrastructure supply. These options which represented a vision of land use, infrastructure and importantly costs and key metrics is essential to any community engagement whereby the cost of the outcome is also readily known.
Using Digital Twins

Digital twins are an emerging new paradigm where the physical world is emulated to allow modelling or outcomes to provide greater insight and improved decision making. They can also have levels of artificial intelligence and learnt routines to help cleanse, analyse and deliver consistent actions or preferred decisions related to the current state or any planned futures.

What are Digital Twins?

The Centre for Digital Built Britain (CDBB) at Cambridge University has released a paper entitled “The Gemini Principles: Guiding values for the national digital twin and information management framework (2018)”. These draft principles were publicly released in February 2019 and have been quickly recognised by government and industry both internationally and in Australia to define and guide the development of digital twins.

With the Gemini Principles Framework Digital Twins are defined as:

“A realistic digital representation of something physical”

Such Digital twins come in two forms being either:

- **Digital twin 1 (DT1):** A dynamic model of an asset, with input of current performance data from the physical twin via live data flows from sensors; feedback into the physical twin via real-time control.

  DT1 is most prevalent as a Building Information Modelling (BIM) and integrated building control, detailed and sophisticated SCADA systems etc.

- **Digital twin 2 (DT2):** A static strategic planning model of a system, with input of long-term condition data from the physical twin via corporate systems; feedback into the physical twin via the capital investment process.

  This form of Digital Twin is not yet prevalent and would be suited to underpin place-based strategic planning, collaboration and necessary governance requirements set out above.

Further the Geminin Principles Framework states:

A digital twin must represent physical reality at a level of accuracy suited to its purpose. The extent of realism depends on three essentials:

- **Data** – the quality of the data on which the twin is based.
- **Model** – the fidelity of the algorithms, the validity of the assumptions and the competence of the code at the heart of the digital representation.
- **Visualisation** – the quality of presentation of the output. Digital twins may be developed for a range of purposes, operate at different scales or adopt different approaches to modelling.
Digital Twins are to ultimately operate in a managed digital environment, including:

- **Information management framework** - Enabling effective information management across the built environment; and;
- **National digital twin** - An ecosystem of digital twins connected via securely shared data.

This managed environment is critical to the sharing of information to facilitate collaboration and place-based planning at any scale whilst ensuring integrity and security in the data.

The Gemini Principles as depicted in Figure 1 must underpin any digital twin to be an effective system to meet the goals and intent of the framework moving forward.

### The Gemini Principles

#### Purpose:
Must have clear purpose
- **Public good**
  - Must be used to deliver genuine public benefit in perpetuity
- **Value creation**
  - Must enable value creation and performance improvement
- **Insight**
  - Must provide determinable insight into the built environment

#### Trust:
Must be trustworthy
- **Security**
  - Must enable security and be secure itself
- **Openness**
  - Must be as open as possible
- **Quality**
  - Must be built on data of an appropriate quality

#### Function:
Must function effectively
- **Federation**
  - Must be based on a standard connected environment
- **Curation**
  - Must have clear ownership, governance and regulation
- **Evolution**
  - Must be able to adapt as technology and society evolve

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- **Purpose** – achieved by systems and software;
- **Trust** – achieved through secure, well designed and managed data hardware and networks
- **Function** – achieved by policy and governance which facilitates innovation and evolution in the purpose for a digital twin but supports protection to ensure continued Trust.

The Principles are critical providing a ‘ready-made’ framework for truly effective and revolutionised place-based strategic planning and the platform from which effective and efficient collaboration can occur. Without an ‘ecosystem’ as set out by the framework, there cannot be quantum shift in current practice to effectively deliver the reform outcomes which are desperately called for by government.

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*Figure 1 - Digital Twin - Gemini Principles: Source DCBB 2018*
Do they have application in Australia?

Yes. While it is only early days there are a number of examples of operating DT1 in practice at varying levels of sophistication. The Qld Government is pursing the digital twin concept as part of the Qld Treasury’s - Cities Transformation Taskforce and leading work by DNRME Cadastre Transformation Team. Government has also established the Australasian BIM advisory Board to drive appropriate innovation and regulation around the development and use of Building Information Modelling (BIM).

Digital Twin 2 is less prevalent; however, DT2’s will be vital in solving many of the challenges set out in the larger reforms touted by government. From our assessment it is clear that a DT2 could facilitate the necessary level of meaningful collaboration and turbo-charge the place-based planning framework. The sharing of these DT2 models or forms of them will allow rapid interpretation of the barriers and opportunities.

Land use and infrastructure managers, industry, financiers, treasury and community can be ‘schooled up’ using a DT2 prior to face to face collaboration, allowing all participants to come armed with a clear focus to maximise problem solving, leverage benefits and optimise outcomes.

What does a DT2 look like?

Integran have been developing a DT2 model for over 5 years known as Outvye® meaning to outdo, emulate and transcend.

Outvye® has a clear Purpose which is perfectly aligned to the Gemini Principles. It is a stand-alone software platform which provides a basis for aggregating corporate data to create a digital emulation of land use, built form, network and site infrastructure and the natural environment at a mapped level. Outvye® has been developed leveraging over two decades of working with local government, the development industry and preparing policy reform at State level in four states in Australia.

Outvye® provides an evidenced based - systemised approach to allow organisations to collaborate, strategically analyse, plan and prioritise expenditure by emulating planning, infrastructure management and financial decision-making processes. An overview of the key modules is set out in Figure 2.
Integran is currently consulting to a range of clients, building and delivering DT2’s in order to provide insight and as a result improved, evidenced based advisory services. We are also implementing a first of kind ‘Strategic Planning for Infrastructure’ project under the Department of State Development Manufacturing, Infrastructure and Planning’s (DSDMIP) Maturing Infrastructure Pipeline Program”. This project is underway with three of our client regional council’s including Torres Shire, Mt Isa City and Bundaberg Regional.

We believe that Outvye® will provide our clients the luxury of time and highly visualised evidence to consider options more fully, empowering their decisions to help build more resilient communities and improve overall sustainability.

Digital Twins are not the panacea to all ill’s but are part of emerging technology that can be employed to help overcome the current planning and delivery challenges by emulating an agreed strategic vision for communities that is viable and importantly deliver their needs.

Ends.

Jason Natoli - Director – Planning, Infrastructure and Governance
P | 07 3227 0500
j.natoli@integran.com.au

References