iHUB: a smart decision support platform for applied urban research, synthesis and engagement

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Figure 1: Highly reconfigurable iHUB smart decision support platform: general arrangement.

iHUB is a network of 5 highly reconfigurable meeting spaces in leading universities in 4 states that facilitate smart decision support from a common infrastructure. iHUB is a state-of-the-art platform for applied urban research, synthesis and engagement. It has five principal components: 4 hardware and 1 software:

1. Each meeting space affords up to 64 individual presentations from laptops, tablets and smartphones to be compared and contrasted simultaneously within a digital pin-up space.

2. Each meeting room hosts a high-end computer with advanced graphics capability with the power to crunch large urban data sets producing spatial visualisation in real-time making use of all, batches of or individual monitors.
3. Each meeting room is connected by Australia’s fastest broadband network (AARNet) enabling teams of urban researchers from across 4 states to collaborate sharing each other’s high resolution visualisations drawn from local urban data sets.

4. As a digital pin-up space each meeting room can host exhibitions drawn from various sources as a visual backdrop to urban research and engagement meetings, or can be a combination of exhibition space and interactive meeting space hosting both presentations and real-time visualisation of urban analytics all at once.

5. Software that provides an inter-operative ‘digital workbench’ for many powerful urban research digital tools that, to date, have not been able to interoperate.

In short, iHUB is a highly adaptable space where visual-analytic material from many sources can be used to cover a landscape of disciplines with vastly different modus operandi, where the visual representation of ideas, theories, facts, postulations, models and scenarios is the most appropriate common ground upon which to be informed, to negotiate, to advocate, and to instruct.

**Hardware components**

Specifically the iHUB facility is comprised of several discrete but connected components. There is a **Power Wall (F3 1.2)** - the monitor array seen at the rear of Figure 1 with a **Touch Wall (F3 1.5)** flexibly located on the right hand side of the image. **Backend computing equipment (F3 1.1)** is located behind the Power Wall. A **truss system (F3 1.3)** in each of the meeting spaces allows for rapid reconfiguration of the **Flexible Environment** (shown here as a circular arrangement) all controlled by a **Dancing Table** described in Section F4 2.1 and 2.2 - Details of non-ARC contributions. The five digital pin-up decision support spaces will connect their data sets through **web hosting**. The teams will also draw on action research facilitated by **eye tracking hardware (F3 1.4)** located at UNSW (not featured in this image).

What makes iHUB unique?

While there are many state-of-the-art immersive visualisation facilities in Australia such as QUT’s Design Lab, Wollongong’s Smart Infrastructure Facility, and Monash’s Immersive Visualisation Platform (MIVP), iHUB will be unique in its innate capability to allow many participants to share visual material simultaneously. The reason for soliciting Australian Research Council (ARC) funding support is to ensure functional homogeneity across all five platforms that would not be achievable if we relied on each research team working through their respective procurement processes. By forming an externally supported consortium we will also be working within the same timeframe ensuring that we share the same versions of equipment, with the price advantage that critical mass brings to purchases of this magnitude.
The iHUB is therefore envisaged as a 4-layer, geographically networked applied research facility for smart urban planning and design (Fig.2). Linked to a dedicated space on each campus (Fig.1), the facility will have computational, visualisation and broadband communications infrastructure capable of supporting all the applied research and engagement objectives outlined below with digital pin-ups, high speed computing, broadband communication speeds enabling real time distributed computing and communication. The data layer initially established in the iHUB will operate as a distributed open data system that draws on databases developed and managed within the partner universities and their affiliated CRC networks (e.g. UNSW's IE Lab data and City Data store), all of which bring more granular built environment data compared to the primarily aggregate data accessible via AURIN (all universities are partners in AURIN).

Imagine politicians, planners, developers, architects, engineers, social scientists, and citizens being able to gather in a room to make collective decisions based on real-time data analytics? In such a facility, key stakeholders, experts, and end-users could probe ‘what if...’ scenarios using 3D simulation to demonstrate the effects of competing urban development possibilities. The collected diverse disciplinary expertise and interests could debate alternative speculations around future cities together and consensually decide appropriate courses of action. There is no such facility in Australia today yet, as a nation, we have all the necessary ingredients but lack the glue to bind them together.

The proposed smart decision support platform for applied urban research, synthesis and engagement, iHUB, will provide the missing matrix that will draw together the best minds, hardware components, software tools and facilities into a virtually connected single resource. The iHUB infrastructure platform will be shared by five leading university-based urban research centres located in Australia’s four most populous regions and linked with three urban-oriented CRCs. iHub will enable the pooling of physical and intellectual resources and contribute to more informed deliberation of potential urban futures. For the first time key decisions can be tested for likely consequences in real-time. This enables all stakeholders to be present, sharing information and a wide assortment of insights with a fluency and timeliness only made possible by the confluence of rapidly improving computing technology and processes, and combining these with distributed urban analytics and design software.

A first for Australia, iHUB will not only afford much deeper and richer insights to guide collective urban development decision-making, it will also act as a compelling demonstrator for federal, state, and local government policy-makers by offering them credible evidence-based glimpses of the future, constructed from multiple perspectives. iHUB will also provide the best possible platform for transdisciplinary urban research, focused on development of a new generation of integrated urban models. And it is reproducible and scalable for new partners.

Making major planning and urban design decisions is a complex undertaking when so many diverse research disciplines are concerned, especially taking into account the need to
integrate associated professional consultants, government agencies and community groups. ‘Cooperating’ rather than ‘collaborating’ is a more accurate description of the current interdisciplinary and multi-stakeholder dialogue, which is oriented towards sequential and often fragmented decision-making managed over an extended period of time. This condition must be addressed to achieve smarter and more sustainable urban planning and design outcomes.

The surge in data acquisition, processing and representation during the last decade, however, has not been adequately addressed by built environment and design (BED) professions insofar as the considerably improved data outputs are not routinely captured/accessed and converted to design inputs. Computer modelling of built environment performance (at building, precinct and city scale) has also been undertaken in silos – as one-off grants to individual research groups or within Co-operative Research Centres (CRCs), with resultant tools rarely being applied to important urban planning and design issues and never integrated. University-based research teams and their colleagues in the built environment design professions and government are seeking the best route to take full advantage of the current and future data and analytics capabilities, and to establish a platform and operating research environment for data driven integrated design and assessment (Fig.3). In a more real-time collaborative environment, decision-making can be enhanced by being undertaken jointly and in a distributed work environment.

iHUB is an initiative that significantly boosts core discovery for 5 leading BED research groups located at universities in Melbourne, Sydney, Brisbane and Perth. They are located in Australia’s largest and fastest growing cities that are experiencing stress related to a failure to plan for futures that have been foreshadowed for over 20 years (Newton et al 2001) and continue to surface in a regular sequence of ‘urban audits’ – most recently by Infrastructure Australia (2018). The universities here all have strategic connections in common to one or more of the three CRCs focused on urban research (CRC for Low Carbon Living, CRC for Water Sensitive Cities and CRC for Spatial Information – respectively CRC LCL, CRC WSC and CRC SI), the National Climate Change Adaptation Research Facility (NCCARF) and the Australian Urban Research Infrastructure Network (AURIN) – all nearing the end of their federal funding. The iHUB network, strategically located at these universities within these cities, provides new opportunities for university-based researchers to work more collaboratively and meaningfully with the professionals and stakeholders tackling our growing cities and regions’ challenging issues. They also represent an initial, formative network (currently restricted in this submission by ARC’s limit of 15 CIs per proposal) for other universities undertaking similar research to connect with as part of a scaling up phase of the iHUB network (eg. The aforementioned QUT’s Design Lab, Wollongong’s Smart Infrastructure Facility etc).

**Software components**

What is the proposed ‘digital workbench’?

The digital pin-up facility is end-user oriented. It integrates both physical and virtual infrastructure based on advanced and remote experimental data capturing networks. The
digital workbench provides the ‘smarts’ that enables the design decision-makers to consider fresh data-driven scenarios together with future planning scenarios in real-time. Through sophisticated data capture, transmission and advanced analytics, and advanced visualisation, experts and end-users will be able to interact with both the data and each other in real-time. iHUB facility supports essential new research into vital but unprecedented decision support capability development as a common platform for technology application and design research teams based at two urban and two regional universities. By 2053, 72% of 28 million Australians will be living in our capital cities, aligning with the global trend where by that date 70% of the 9 billion-plus global population will live in major cities (Infrastructure Australia, 2018). 15 highly experienced Chief Investigators (Cis) from diverse engineering and design backgrounds are brought together by the proposed iHUB facility, thus perfectly placed to embrace the consequences of this trend towards urbanisation that creates major challenges for the future planning of cities and regions in a sustainable and equitable manner. Central issues to be addressed include accounting for how services are designed and delivered, how infrastructure is developed and how communities of stakeholders and decision-makers are brought together. The CIs have engaged with many potential stakeholders during the preparation of the proposal to gauge the likelihood that they would collaborate on research projects supported by the proposed iHUB facility. As such it will be styled as a proof of concept sandpit to test the effectiveness of creative new solutions for rapidly changing built environments.

The software layer represents a significant repository of computer-based tools developed by university partners attached to one or more of the three ‘urban’ CRCs listed above and AURIN (all with their legacy objectives to achieve), as well as those available as open source. They are extensive (see cluster of CRC tools on LHS of Fig.4), but currently exist as separate tools, mostly new prototypes awaiting wider exposure on actual projects (eg. via integrated assessment in research synthesis projects), subsequent hardening, and where strategically important, developed as integrated multi-factor models. There is an opportunity here to respond to repeated calls for creating a capacity for integrated urban systems analysis and modelling (SBEEnrc 2017). The challenge is also to develop links to leading global commercial software systems central to BED.

![Fig.4 Clusters of BED-relevant software (federally-funded CRC tools in LHS cluster)](image-url)
The engagement layer is where the digital tools for participatory planning that are present and emerging in this consortium can be further developed and implemented in multiple contexts ranging from strategic metropolitan planning to precinct-level design plans with state and municipal government. iHub may enable broader and deeper citizen engagement through a series of demonstrator projects exploiting the team’s collaboration as a single virtually connected facility through the requested LIEF support for an iHub network. iHub facilities will do this in part through ‘digital pin-up spaces’ and test-beds supported by an advanced online visualisation and mapping platform where participants can assemble physically as well as virtually to compare and contrast data streams and scenarios in ways that have hitherto proved impossible because of infrastructure, data, software and academic critical mass limitations. Researchers and associated professions as well as community groups will have the opportunity to engage in real-time transdisciplinary, multi-site, design-oriented decision-making on large scale ‘wicked’ problems: planning for fast growing cities, regenerative redevelopment of cities, future infrastructure development, future housing typologies, transitioning to new governance and engagement systems - among other core challenges. The engagement layer is also envisaged to extend to independent off-site citizen engagement via social media and smart phone devices to encourage their participation ‘from the couch’ at home: another new hitherto unexplored frontier for urban research.

The proposed facility will be unique in the world as specified in this application and as it relates to the BED field of research, and is therefore a first for Australia. UCL’s Urban Dynamics Lab (incorporating the Centre for Advanced Spatial Analysis), ETH’s Future Cities Lab, MIT’s Senseable City Lab, the Urban Big Data Centre at the University of Glasgow and Arizona State University’s Decision Theatre are all internationally recognised urban research Laboratories but are firmly tied to a specific university. The iHub consortium have established links to these Labs via the senior CIs in this Consortium, and as a facility and resultant research partnership iHub would help consolidate these linkages more formally should this application be successful. A second phase of this proposal, aligned to federal government Smart Cities and Suburbs policies, programs and grants, would target selected municipalities in all iHub cities with an objective of installing networked iHUBS (and technicians) within their offices with the explicit objective of increasing their capacity for transformative change in their jurisdictions.

FEASIBILITY

The proposed iHub facility aligns with all of the participating universities’ strategic plans that strongly feature both sustainability and digital transition objectives. Research into the multiple pressures on built environments and ways to ameliorate them through effective planning and design are among the key priorities at each university.

All five universities in this consortium have faculties, schools and centres with established national and international reputations in BED and allied fields of research, and have been undertaking significant investments in new initiatives and senior appointments in these areas over the last two years. All have formal partnership in one or more of Australia’s national urban research networks:

- Swinburne: Institute for Smart Cities and Centre for Urban Transitions (and CRC for Low Carbon Living, CRC for Spatial Information, AHURI, AURIN, SBEEnrc, iMOVE CRC)
- UNSW: City Futures Research Centre, City Analytics Lab (CRC for Spatial Information, CRC for Low Carbon Living, AHURI, AURIN, SBEEnrc, iMOVE CRC)
Monash: Departments of Architecture and Civil Engineering collaboration through CRC for Water Sensitive Cities and the Urban Lab, establishment of a new Urban Planning & Design program in 2018, building expertise in data analytics for urban development, land use and transport

University of Queensland: Faculty of Engineering, Architecture and Information Technology (CRC for Water Sensitive Cities, iMOVE CRC)

Curtin University: Centre for Urban Sustainability Policy (and CRC LCL, CRC SI, SBEEnrc)

The proposed facility is of high strategic relevance to the university partners combining to form an urban futures research collective through the creation of the iHUB networked platform as a shared resource enabling realtime urban research collaboration over the entire extent of our continent. The ability to conduct discovery-level applied planning and design research, and engagement through combining the very diverse set of skills from all partner institutions will be a big draw card for developing strong linkages with BED industries and practitioners with a focus on options seeking, problem solving, and impact.

In this context, the CIs in this Proposal have established strong and trusted working relationships over the past decade in arenas where collaboration has been enabled by partnerships in major nationally funded research initiatives.

Connections with multiple CRCs and National Research Networks means that this Consortium of CIs has an un-matched network of senior connections in government at all three levels, leading private sector firms with a global reach, key industry associations and the built environment professions. All of which enable strong engagement in and potential funding of iHUB applied research activities. If this proposal were successful, the network could be expected to expand significantly, especially if linked to a Future Cities CRC.

INVESTIGATORS

The individual CIs are all acknowledged experts in their fields with national and international reputations, and have come together to seek a new avenue along which they can take their research and applications, both individually - but more importantly, collectively: targeting solutions to the nation’s biggest urban planning and design challenges. The urban research endeavours of the CIs in this Proposal span disciplines that intersect significantly, providing the basis for interdisciplinary applied research. The problem domain - urban and regional development futures - is extraordinarily large and complex, with challenges that demand a critical mass of research expertise and professional practice and novel initiatives to test scenarios in real-time - affording responses that are both more effective and efficient than is possible using current sequential decision-making with disparate sets of individuals and tools. Through the proposed facility they will be strongly positioned to undertake core research in new arenas, and at a deeper level through combining their respective skills and perspectives to attack the grand challenges around urban development in fresh and exciting ways.

The lead CI is Peter Newton, FASSA, Research Professor in the Centre of Urban Transitions at Swinburne University of Technology (an urban Research Centre established in the early 1980s). Prior to joining Swinburne in 2007, CI Newton was Chief Research Scientist at CSIRO and Deputy Chief of its Division of Manufacturing & Infrastructure Technology, as well as leading CSIRO’s built environment research for over 20 years. He is formally involved in all six national urban research networks and has made pioneering contributions to city information modelling, precinct information modelling, building information modelling
and their applications (highlighted in ROPE). He has also collaborated productively with 80% of CIs on this proposal. His principal role will be in overseeing the establishment of the Facility and providing thought leadership.

The combined CI ROPE statements demonstrate unequivocally where the iHUB adds new capacity to individual research areas, given that the BED field of research has been slow to develop 'laboratory' facilities aligned to researcher and practitioner requirements, still less stakeholder and end-user engagement. The rapidly evolving digital revolution of the past 20 years is now at a stage, however, where design science, social science, information science and urban planning can capitalise to a significant degree. The iHUB platform will positively enhance BED R&D.

The iHUB assembles leading researchers from 4 CRCs (LCL, SI, WSC and iMove) with high level links to AURIN, SBENRC and NCCARF that contribute core capabilities:

- From WSC- CI Keller (Research Director across all programs), CI Kenway (leader if its major urban infill project, and Australia’s expert on water-energy interactions) and Urich (leader of the integrated WSC toolkit)
- From LCL and SI- CI Newton leads a low carbon precinct program and is a collaborator with CI Morrison - a leader in European and Australian living laboratories R&D in the context of planning (a common objective with iHUB); and with Keller and Kenway are seeking to develop a conceptual and analytic framework for designing low carbon and water sensitive cities
- From an urban design perspective, leading researchers from Swinburne (CI Burry, CI White), Monash (CI Murray, CI Grodach) and UNSW (CI Haeusler), are all connected via CRC partnerships related to design-led innovation
- From an urban modelling perspective, CI Pettit leads a key UNSW Spatial Analytics facility; CI Dia is Department Head of Swinburne Civil Engineering School and its Urban Transport program – a partner in iMove CRC; and CI Liu is an expert in GIS modelling at Curtin and linked to CRC SI.
- From a broader perspective of computational research, CI Rohl leads Curtin's collaborative cross-faculty computational research facility - central to the integrated modelling objectives envisaged for the iHub

All the CIs listed in this proposal have links to and work closely with a large group of PhD students, post-doctoral and early career researchers in their universities and centres, most of whom will have significant involvement in the iHUBS. They are likely to introduce much of the innovation that will subsequently emerge, guided by the CIs in the first instance.

The CIs/PIs listed in the proposal who will be most closely involved with the purchase, installation, maintenance and co-ordination of access to the iHUB infrastructure have had a close association with similar activities in recent years.

**BENEFIT**

*Availability of similar infrastructure.* As described above, the iHUB facility is focussed on developing an entirely new and urgently needed nationally networked university-based research capability for Australia at a time when AURIN, the three urban-oriented CRCs and NCCARF are nearing the end of their federal funding. The iHUB represents a network capable of connecting and sustaining the linkages and outputs that have emerged from these significant national investments. The sustainable development of future built environments is one of the grand challenges currently facing cities and regions - where CRC-research has developed an impressive researcher community, knowledge base and analytical toolkit that
should be capitalised upon. Addressing this challenge requires new applied research into comprehensive and transformative approaches for supporting the decision makers responsible for managing and developing cities using integrated data-driven modelling and engagement approaches pioneered in the CRCs, NCCARF and AURIN. Empowered by broadband connectivity, new opportunities for linking distributed researchers, integrating spatial analytics and extracting crucial information from vast pools of data have never been better. However, to leverage this opportunity and enable evidence-based design decision making requires the development of this new networked facility. To our knowledge, there is no other infrastructure of the same scale of ambition and distribution anywhere in the world.

**Demonstrated needs.** The research projects envisaged to be supported by access to the iHUB facility and affiliated researchers are significant and transformational. There are at least two major classes of transformative collaboration capable of being enabled by the iHUB – outlined below, together with a specific set of illustrative **USE CASES:**

1. **Integrated assessment and research synthesis** (again, see Fig.3). Research synthesis and (geo)design-led thinking represents a new model for rapid-fire engagement between researchers and end-users (government, industry and community – in multiple combinations) to unlock opportunities that stem from the new knowledge and analytics. These can be focused on critical urban development problems related to new transport, water, waste and energy infrastructure, infill housing in brownfields and greyfields etc. Pioneered by CRC Water Sensitive Cities ([https://watersensitivecities.org.au/?s=research+synthesis](https://watersensitivecities.org.au/?s=research+synthesis)) this is an engagement methodology perfectly suited to the iHUB networked facility utilising 21st century digital infrastructures. It requires integrated assessment as a critical input, achieved by assembling real-time input from distributed research experts and practitioners and their specialist software tools generating spatial analytic outputs related to a specific urban place and challenge. These would be displayed on multiple digital pinboard screens in real-time, with digital mark-up tools (compared to Powerpoints of outputs currently shown sequentially by experts parachuted into a workshop). Critical tacit knowledge from the assembled working group can rapidly assess and synthesise the outputs to create new planning and design options evaluated on the fly which, in many cases can be further assessed during the meeting (a major boost to creativity and productivity)

**USE CASES:**

- **Regenerative urban infill** design and assessment. Achieving targets of 70% urban infill is a common target for Australia’s largest cities, but is failing in multiple aspects related to failures in equitable and effective planning, precinct design and community engagement; iHUB is a space for researchers to demonstrate potential solutions in an interactive digital environment.

- **Strategic metropolitan planning** for Australia’s capitals requires significantly greater horizontal and vertical integration among government agencies than is presently the case; iHUB is a governance engagement platform where researchers can facilitate informed evidence-based dialogue with government partners.

- **With the proliferation of digital planning and design tools** there is the critical need to ensure these tools are fit for purpose. The iHub platform also provide the dual purpose to enable researchers to study **how** planners, policy and decision-makers best interact and use digital planning and design tools in order to undertake city shaping activities. It will also offer unique opportunities for research into the change management challenges that transitioning into a digital equivalent of analogue processes that to date have proven extra resistant to evolution.
There is a large and immediate market for this capability, which would be self-funded providing academic researchers with a front-row seat in helping steer contemporary urban planning and design.

2. **Integrated modelling** (see Figs.3 & 4) There are more than 20 computer-based models that have been developed in three CRCs, AURIN and NCCARF that have focused on particular aspects and scales of urban performance assessment (again, see Fig.4), amongst which prominent examples are MUSIC, Dance4Water, ENVISION, RAISE etc. There has been no mechanism for co-ordinating software development within domains (e.g. energy, water) much less cross-domain (integrated) modelling in these research centres. An initial challenge is to develop software that allows existing bespoke tools to communicate with each other (data interfaces that allow communication between disparate software products, for example). The software would also need to allow input from and output to commercial off-the-shelf software currently used by the design industry). There are many areas where significant value could be added to end users in government in areas such as strategic planning such as greening suburban transport, and the increasingly challenging local government’s Development Assessment of new urban projects (e.g. urban heat mitigation from higher density redevelopment), made possible if the intermeshing of currently fragmented CRC tools could be undertaken. With the proposed iHub infrastructure, high quality LIDAR 3D mesh city models could be used with real-time feedback of aggregated shadows cast (e.g. shadows for every 30minutes between 9am and 4pm any day of the year) for potential development sites within the city context. Planners, architects, engineers, developers and other key stakeholders could come together and interactively adjust a development site’s height and set back parameters, or test the impact of several design proposals to balance desires to maximise potential yield whilst ensuring development does not overshadowing key public open spaces such as parks and squares. And all the time seeing a time-based real-time 3D (spatial) interactive representation of the ‘what if…?’ scenario outcome.

Within AURIN, a major investment was made in relation to walkability modelling of a locality, but alternative methods are emerging including using space syntax of street networks integrated with active transport determinants; agent-based pedestrian accessibility modelling, topography (steepness), thermal comfort and microclimate and shade mapping, pedestrian risk, and air pollution modelling to provide a powerful decision support system for urban designers and policy makers.

Similar examples of fragmented approaches exist in relation to adaptive planning for cities in the context of climate change (e.g. sea level rise and catchment flooding - a multi-jurisdictional and multi-factor problem for city planners). NCCARF and CRC WSC has been a focus for a significant component of this modelling (e.g. their software CoastAdapt and Dance4Water), but it is also within 12 months of their federal funding concluding, and it is critical to have a means of capitalising on this investment.

**USE CASES:**

- Interoperability of pan-CRC software: three CRCS have developed specialised spatial tools for specific aspects of built environment and assessment. iHUB offers the first opportunity to begin integrating these scenario modelling tools into a common digital spatial architecture; allowing each speciality focus to interact with a common model and thus achieve a near complete analysis of urban change modelling scenarios. An example of a use case would be analysing the location of new transport infrastructure calculating the value uplift around these new stations, then determining the financial
viability of a new redevelopment precinct (economic assessment), passing the model to flood analysis software, then passing the model to UHI and carbon assessment tools (environmental assessment). All of these systems would have the capacity to alter and optimise the precinct model, which could continually be iterated until it reaches a satisfactory outcome for its urban context. There is a significant software stack of urban design assessment tools resident in collaborating universities that can contribute to this objective (Fig.4).

- Synchronous distributed computing/collaboration/co-working: 25 years has elapsed since real time collaboration between geographically dispersed researchers and practitioners on 3D Building Information Models (BIM) was demonstrated as being technically viable (Newton 1994). This challenge remains for urban planning to harmonise spatial information architecture in order to service the joint requirements of BIM, PIM and CIM that is crucially lacking (Newton et al 2017; Burry et al 2015). By exploring mechanisms to deploy and manage simultaneous instances of software, users will be able to jointly work on the same scenario remotely. This would require transfer of alterations from one model to another, occurring seamlessly between locations. The benefits of this system would be that experts can jointly, though remotely, access the same modelling scenario, making alterations as they see fit and without needing a single centralised project or a “driver”. A use case for this system could involve a user in Queensland versed in housing models, one in Sydney versed in urban runoff and drainage and urban heat island assessment and a user in Melbourne with knowledge of local development and zoning regulations, to collectively explore implications of urban densification at a much more profound level than is currently possible. While one user alters the spatial definition of the dwellings, other could be altering the drainage solutions for the precinct, while another could assure that the model adheres to the planning regulations of the area – or identifying where they need to change. iHUB offers the opportunity to begin integrating these scenario modelling tools into a common platform; allowing each speciality to interact with a shared model and thus conduct a near complete analysis of urban change modelling scenarios. Through the iHub physical Facilities located in Victoria (Swinburne) and Sydney, (UNSW) participants will be able to interact with the models and each other through supporting available technology including interactive touch screens, projectors and supporting software, data and models.

**Benefit of the proposed research infrastructure.**

There are an increasing array of research challenges that can be directed towards addressing the multiple disconnects that are currently inhibiting sustainable urban planning and development of large fast-growing cities: namely, the lack of:

- Interdisciplinary engagement across the Built Environment and Design sector and affiliated fields of research in tackling wicked urban problems
- Effective urban governance involving enhanced horizontal engagement and integration across the multiple ministries involved in strategic metropolitan planning
- Vertical integration between state level strategic planning (and zoning) and local government statutory planning and associated development approval processes
- Real citizen engagement associated with significant urban development issues; eg. proposed neighbourhood change
- Integrated urban assessment and integrated modelling capacity; that inhibit effective attempts at research synthesis for major urban development proposals/projects
- Real time, geographically distributed, synchronous communication and research collaboration platforms (enabling telepresence, co-working, co-designing etc)
- An urban data repository (open data) that builds on AURIN’s aggregate data with parcel scale ‘built environment’ data critical to urban design

The rate of use of the iHUB facility in relation to these topics would be high (see Research Infrastructure Arrangements).

**Broader access.** At the core of the iHUB networked facility are the key organisations named in this Proposal, given their demonstrated commonality of applied research interests and CRC working relationships. The initial challenge is to assemble the iHUB’s infrastructures as detailed and commence research engagement within that network. This iHUB concept does, however, provide opportunities for subsequent scaling up:

1. To further university research groups within Australia, via future LIEF, Linkage and CRC proposals, to ensure common research infrastructures are provided to later entrants
2. By linking in state government and local government agencies with federal Smart Cities and Suburbs (SCS) funding support (City of Melbourne has expressed interest here as has City of Maroondah and City of Fremantle, recipients of recent Smart Cities and Suburbs funding)

**COMMERCIAL BENEFITS.** Integration with existing commercial urban analysis (model transfer and incorporation into commercial systems) – see Fig.4. Many off-the-shelf commercial packages (e.g. ESRI, AutoDesk products) already have the capacity to integrate server based systems, where the clients are managed centrally and thus can be accessed simultaneously. Also, packaged suites (e.g. Autodesk products) currently allow for models to be passed between the ranges of packages in the suite. There is therefore the possibility of working with these systems to incorporate specialist modules that extend current functionality of design assessment.

**EDUCATIONAL BENEFITS.** It is envisaged that the iHub will be a major magnet for graduate and post-doctoral students who would benefit greatly by access to a critical mass of built environment experts and leading edge technology. Students from Monash’s Urban Planning & Design program and Department of Architecture as well as the UNSW’s Computational Design and Master of City Analytics Program and Swinburne’s Master of Urban Design would greatly benefit from accessing this infrastructure. Additionally, the physical iHub spaces at each university would enable design studios and charrettes to be run individually and across the cities.

New data generated from publicly funded research would be stored on the UNSW City Data store (https://citydata.be.unsw.edu.au/). The data store, will provide access to open data which is downloaded and interoperable with existing-infrastructures such as AURIN and Research Data Australia.

**COMMUNICATION OF RESULTS**

The principal intention of the iHUB facility is to facilitate a far richer dialogue between stakeholders, experts and end-users an order of magnitude greater than possible through ‘town hall’ style meetings, paper-based or on-line questionnaires, and powerpoint-fuelled workshops. In each city the iHUB facility will catalyse research with diverse sets of players. Each CI will lead projects making use of all the iHUB capabilities
Each of the university research centres associated with this proposal has established communications networks capable of being linked with the iHUB to publicise its activities and progress including leading media and graphics; eg. UNSW’s CityViz (https://cityfutures.be.unsw.edu.au/cityviz/) – for the display of interactive mapping outputs including for example housing, mobility and health indicators; Swinburne’s Australian Policy Online website etc..

**MANAGEMENT OF DATA AND ASSOCIATED SOFTWARE**

The iHUB networked facility is envisaged to operate as a co-operative distributed operation. The exact terms of collaboration on integrated software development would be determined if this Proposal is successful. It would likely be implemented through an open source software solution building upon a number of existing open source tools developed by universities in the iHUB network. Business cases would need to be developed. Collaboration on integrated assessment and research synthesis is more straightforward and would respond to specific, funded, requests for collaboration with government or industry partners.

Software catalogues would be created that detail holdings in each university or CRC partner institution, providing information related to their capacity for utilisation in integrated assessment/research synthesis applications and engagements as well as specific functionalities that can be significantly enhanced via integrated modelling projects undertaken between the research partners and proprietary spatial software developers (as but one option).

Underpinning the digital planning and design software layer will be the city data store, which will maintain metadata of core city datasets. This datastore will provide interoperability and support machine to machine connection between the iHub digital planning tools. The fundamental basis of this City data store, which is built on the geonode open source software stack, has been implemented as part of Urban Analytics Data Infrastructure ARC LE160100174. This datastore and its underlying data model will extended further to accommodate 3D BIM, PIM and CIM models. This datastore has been tested as to be interoperable with the AURIN platform and National Map.

**RESEARCH INFRASTRUCTURE ARRANGEMENTS**

*Arrangements for purchase, construction, location, etc to facility.*

A space within each of the universities will house the iHub as a fixed facility.

It is envisaged that a **common infrastructure platform** will be established in each university via the LIEF grant that will enable full functional research and engagement activities envisaged/outlined in this submission to be undertaken in a seamless fashion. Specialist items of infrastructure outside this grant and specific to individual universities are also likely to be assembled over time.

A HEW Grade 8 technician will be required to design, install, and implement the proposed equipment items linking them all as an integrated 'real-time urban futures decision support facility’.

The project envisages significant bandwidth between the three partner universities.

*Access*

Three levels of access are envisaged that result in maximum use of the facilities:
Level #1: Level 1 envisages the equipment and facilities are being used for research projects that all universities are participating in. These projects will take priority over Level 2 access.

Level #2: Level 2 envisages the equipment and facilities are being used for research projects that a majority of the universities are participating in. These projects will take priority over Level 3 access.

Level #3: Level 3 envisages booking out individual items of equipment to research teams with accredited expertise (by the host institution) for specific tasks. Access will be by web booking that incorporates sign-off from the host research leader. Any cost of using the infrastructure will be borne by the host institution without expecting any cost sharing.

The equipment sought will be made available to appropriately trained iHUB researchers at all partner institutions, and used to engage external stakeholders (government and private sector), experts (university based researchers and external practitioners) with citizen end-users. There will be a common infrastructure as well as items that are university funded outside the LIEF grant, but located in a specific iHUB, and highly adapted around the facilities within which they are housed at the respective custodian universities, tailored to the specific research foci of each host institution. Once set-up (significant technical challenge), the researchers, adequately trained, will find using the individual equipment items will not be a sophisticated technical challenge. Researchers from each participating university will be able to access their own equipment or that located at a partner institution under the access rules identified above. There will be shared protocols across the participating institutions for accessing each other’s equipment, software and data.

As a research collective, we anticipate a high level of local government, industry and professional interest through the demonstrator research projects that the shared facilities will promote. It will be in the interests of all partners to develop joint planning/design research projects in order to use the proposed facility to promote the extraordinary technical, engineering, social science and design collective that the Chief Investigators grouping represent. No such facility exists in Australia; while some of the individual components and suites exist elsewhere outside Australia, their combination as a real-time design decision support facility is unique, hence this proposal.

**Costs associated with management of facility.**

The iHUB nodes are strategically positioned within established Centres, Schools and faculties in each participating university where this infrastructure is seen as central to current as well as future progress of research. All partners have agreed to support ongoing maintenance of this investment.

**REFERENCES**


SBEnrc (2017) Big City Planning and Digital Tools - A Sustainable Built Environment National Research Centre (SBEnrc) Industry Report, Curtin University, Griffith University, Swinburne University, UNSW, Sustainable Built Environment Research Centre, Australia.