Harnessing the Environment for Socio-ecological Encounters and Knowledge Spillovers: Lessons from the Greater One-north (GO) Creative City Design Explorations

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Abstract: Knowledge cities may be understood as cities that rely primarily on the global knowledge economy such that they attract the creative class in our globalized world. Examples include but are not limited to New York City and San Francisco. As East Asia undergoes rapid urbanisation, more cities, e.g., Shenzhen, are modelled to capture the economic benefits of ‘knowledge spillovers’ (Henderson, 2007). The Knowledge Spillover Theory suggests that innovation is concentrated in some quarters of the city because of informal social exchanges across co-located industries. Business incubators are often introduced to accelerate these processes. For instance, Launchpad@One-north, Singapore, is surrounded by media corporations, a university, a business park, mass transit, and nature areas. The Greater One-north area required spatial planning as more intensive developments were expected to serve future housing along the southern waterfront. Action research-by-design was employed to examine the economy-ecology outcomes from scenarios of varying densities. In this paper, we identify two types of economy-ecology synergies that may be achieved by careful spatial design for socio-ecological encounters. Four scenarios with different orientations toward the economy-ecology dichotomy illustrate these to varying degree. Overall, a high-quality environment is synergistic. Simultaneously centring humans and nature may attract talent and accelerate innovation in knowledge cities.

Keywords: Socio-ecological encounter; knowledge city; knowledge spillover; spatial planning; research-by-design

1. Introduction

Considering the well-being of people and biodiversity on equal footing in urban planning requires clear articulation of their synergistic pathways and mechanisms. In the absence of these articulations, this research “transcends paradigms” (Costanza, 2014) by acknowledging the economic objectives of developers while attempting to address (1) property and (2) resource conflicts in the “planner’s triangle” (Campbell, 2016) in a spatial planning exercise for a real-world client. This paper examines one of our two overarching paired questions in the economy-ecology dichotomy:

(2a) How might the retention of greenfields enhance informal social processes that support innovation in a knowledge economy?
(2b) How might density and new technologies introduce contact with nature to support the well-being of people and nature in a knowledge city?
These questions simultaneously extend Campbell’s conceptualisation of economic objectives to global levels while zooming in to everyday lived experiences at individual- and city-levels. This paper aims to investigate how economy-ecology outcomes of different spatial planning proposals affect ‘knowledge spillover’ (Henderson, 2007). We build on a study which examines the varying impact of differing spatial densities and configurations on the outcome of knowledge, science, or creativity-driven city development.

In the knowledge economy, knowledge is conceptualised as the main driver of production (Virno, 2004, p. 64), and as such the knowledge-based economy has become the main driver of urbanisation (Westlund, 2014). Ingi Edvardsson and colleagues defined ‘knowledge city’ (KC) as a city where “both the private and the public sectors value knowledge, nurture knowledge, spend money on supporting knowledge dissemination, and discovery and harness knowledge to create products and services that add value and create wealth” (Edvardsson et al., 2016, p. 538). In developing KCs, design can play an important role in ameliorating the capitalist commodification of knowledge and spaces (Thrift, 2006) as a common instrument to ‘create new modes of collective becomings’ (Grove, Krivy, Rickards, Schliwa, Collier, Cox, & Gandy, 2019). For example, the density of the built environment and the compositional characteristics of spatial proximities can influence how common needs in a knowledge economy are satisfied (Westlund, 2014).

In contrast to dominant approaches in extant studies, our study uses a bottom-up approach through the method of research-by-design in conjunction with an urban planning studio to understand the impact on and role of ecology (broadly defined) in practice- led solutions for KC development.

2. Theories and Methods

2.1 Knowledge spillover: An ecological economic concept

Knowledge spillover may be understood as a specific form of positive externality when formal research and development or informal learning in firms and universities benefit another entity, including individual employees, new ventures, or other firms that utilize the new knowledge (Hua et al., 2022). A wide range of literature from economic geography to cluster research frame KC planning as a spatial intervention to facilitate and derive societal benefits from knowledge spillovers. Geographers Bjørn Asheim and Eric Clark (2001) assessed the ‘creative city’ as ‘imagineering device, place marketing tool, and urban policy lodestar’ (p. 808). More critically, geographers Ron Martin and Peter Sunley (2003) described a Marshallian industrial district or cluster as little more than a well-marketed ‘brand’ that “at its core is based on an image of a high-productivity, knowledge-rich, decentralised, entrepreneurial, and progressive economy within the reach of local policymakers” (p. 29, emphasis added). As such, knowledge spillover is always (g)locally contextual and ecological.

Formally, the knowledge spillover theory of entrepreneurship (KSTE) explains how and why knowledge ‘spills over by entrepreneurship and generates growth and progress for society’ (Ghio et al., 2014, p. 9, emphasis added). Associated concepts with spatial implications include global knowledge pipelines (Bathelt et al., 2004), new knowledge ventures (Ghio et al., 2014), and psychosocial knowledge atmosphere (Marshall, 1890; Raffaelli, 2001; cf. Gan, Fung, & Cho, 2021). Briefly, knowledge pipelines allow the inflow of market knowledge and innovation to energise ‘local buzz,’ which needs to be nurtured (Bathelt et al., 2004). Since investing in research and development inevitably results in some knowledge that may not be directly relevant to a company, setting up spin-offs or new ventures based on these and other knowledge, including tacit knowledge, harnesses these otherwise unutilised resources for local economic growth (e.g., Ghio et al., 2014). Whether the local information flow yields productive outcome depends on its psychosocial atmosphere, which necessarily decays with distance (Audretsch, Lehmann, & Warning, 2005; Lee, Hong, & Sun, 2013), is not easily transplanted (Marshall, 1890) and requires effort (Gan & Best, 2021). Together, they facilitate economic growth via knowledge spillovers.

Given our spatial planning purposes, we extended the concept of knowledge spillover with the actor-network theory (Hua et al., 2022). Briefly, Porter (1990) argued for the colocation of supporting and rivalrous firms to generate competitive advantage in a study of productivity across 10 nations. But Jon Swords (2013), a researcher of creative clusters in the United Kingdom pointed out that the process of knowledge spillover is a black box
in reality, which is ‘opened and exposed to a critical light that [potentially] destabilize[s] the actor-network’ (p. 379). From a macro perspective, geographer Jamie Peck (2014) echoed David Harvey’s (1989) criticisms that entrepreneurial urban governance commodifies places to generate very narrow forms of innovation. David Audretsch and Maryann Feldman (1996) parsed apart knowledge flow from locational effects on the concentration of innovation activities. They showed that innovation clustered due to the actual sharing of knowledge and not simply because the firms were near one another. These garnered scholarly attention on knowledge spillover in small, multi-sectoral communities.

2.2 Translating knowledge spillover into spatial planning?

Despite uncertainties around the mechanisms of knowledge spillover, one may postulate several spatial intervention strategies that interweave multiple factors. KCs require (1) conducive environment for knowledge production and exchange. Barron and Harrison (1981) show that creativity is affected by motivation, role models, places, and working schedules. For example, thought leaders that motivate innovation may be more easily encountered in cities that (2) draw together different, but complementary ways of knowing. Knowledge work may require quiet space for independent thinking and social space for communication. Enabling and inspiring work spaces are important but (3) adequate and comfortable living environments, including natural environments, are also necessary. Affordable housing, accessible and high-quality amenities and health provisions, and convivial public spaces could better attract knowledge workers.

Multiple institutions, infrastructure, and services working synergistically together are required to support these KC development strategies. They entail socio-aesthetic judgement to strike a reasoned and ‘dynamic balance,’ e.g., for comfortable working and living spaces at the individual level. High-quality residences usually result in expensive houses or apartments, but affordable housing is required for young entrepreneurs, students, and supporting workers. A shorter commute increases life satisfaction, which may be important for sustaining innovation (Richardson et al, 1974; Garrod & Willis, 1992; Stutzer & Frey, 2008). Convenient public facilities and neighbourhood spaces should support various lifestyles (Lennard, 1987). Richard Florida (2010) argues that lifestyles affect where people choose to live and work. The distribution, quality, and availability of affordable housing are critical to satisfy of all the three knowledge job types and support a thriving (human) ecology (Niedomysl & Hansen, 2010).

At an organisational level, a mix of institution types and sizes is also required. According to planner and geographer Gregory M. Spencer and colleagues (2010), the presence of industry-specific clusters is associated with higher average income and employment growth in Canadian city-regions. Their careful operationalisation of industrial clusters partially accounted for general urban differences that may have altered these economic performances. This was in line with Feldman and Audretsch (1999) who found that ‘diversity across complementary industries sharing a common base’ (p. 427) increased benefits from research and development. Large firms were more likely to spend on research and development which may spill over such that small firms in clusters with more large firms would exhibit more innovation (Acs & Audretsch, 1988, p. 687). High-technology firms were more likely to be found nearer to universities that produced more science graduates than social science graduates (Audretsch & Lehmann, 2005, p. 1199). Both large firms and relevant universities are sources of knowledge spillovers that may be exploited. How these institutions sit on and fit together within a landscape is subject to different spatial planning decisions.

2.3 Method: Research-by-design

In view of the permutations that may result from various planning practices and emphases, we adopted ‘action research-by-design’ to study the economy-ecology outcomes of possible spatial planning solutions, also known as design-based research. Research-by-design is based on the notion that some practice-based knowledge cannot be accessed through conventional deductive approaches but requires systematic observations and sense-making from messy (but often coherent) practices. Contextual, in-situ observations in studio settings provide insights into considerations and processes of design activities, which target specific, everyday issues, and are crucial for practice-based knowledge. Compared to conventional research, research-by-design focuses on the action of professional and creative practices, to produce tacit and experience-based knowledge that are not easily accessed by other means. It admits as data a plurality of design tools and expressions such
as drawing, writing, distributing, and performing into the arena of urban studies. As urban study inevitably involves particular spatial information and immediate experience of local context that sometimes cannot be easily illustrated and communicated by non-spatial research methods, research-by-design offers unique insights to articulate and rethink situated knowledge among urban practitioners.

On the premise that knowledge spillover processes are embodied experiences, investigative explorations, drafting, modelling, design critiques, especially through engagements with the community of planners, developers, scholars, and space users, as well as reflection are important for practice advancement. Through these activities, planners gradually form their ideas of feasible and ideal spatial solutions, e.g., to facilitate better knowledge exchange and/or enhance natural assets. The primacy of inductive analyses does not negate, but complements quantification. Compared with various technological methods in extant studies, research-by-design is uniquely positioned to yield new, ‘intuitive’ concepts and issues, and may therefore result in more persuasive and feasible socio-spatial solutions, e.g., that which enables knowledge spillover.

A four-step procedure culminating in ‘collision analysis’ guided our data collection and analysis processes, which may or may not mirror planners’ processes. (1) Mapping focuses on the historical development; the extant cultural and creative infrastructure; land use and ownership, and contextual analysis including the extant transport and green network. (2) Community engagement includes interviews with stakeholders like the government, estate developers, industrial operators, and residents for their contribution to the idea of KC development. (3) Design proposals transform demand into spatial configuration, and synthesize proposals into feasible design options. (4) Design collision analysis identifies ‘where local and national global competition interests come face-to-face and, in some cases, collide’ (Evans, 2009, p.1007), and forms the basis of our economy-ecology discussion in this paper. Specifically, we compared the economy-ecology outcomes across various planning solutions.

2.4 Observation site: NUS planning studio

Participant observation was carried out at a master-level urban planning studio at the National University of Singapore (NUS) in 2019. The planning brief was developed in conjunction with Jurong Town Corporation (JTC) — a government agency that develops and manages state-owned industrial land, including 812 hectares around One-north, a medium-sized employment centre west of Downtown Singapore. The studio brief required student planners to propose spatial plans in six teams, each focusing on a distinctive spatial quality, namely mobility, centrality, spatial continuity, work-life balance, and nature and human connections. For the purposes of our comparative ‘collision analysis,’ these

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<th>Mapping</th>
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<td>• Historical development</td>
<td>• Interviews and Conferences</td>
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<td>• Cultural and Creative atmosphere</td>
<td>• Government</td>
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<td>• Land use and ownership</td>
<td>• Estate developers</td>
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<td>• Transport connection</td>
<td>• Knowledge industries</td>
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<td>• Green Network</td>
<td>• Employees and residents</td>
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<th>Collision Analysis and Synthesis</th>
<th>Design Proposals</th>
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<td>• Interviews and Conferences</td>
<td>• Transforming demand into spatial configuration</td>
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<td>• Negotiation between design expertise and community demand</td>
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<td>• Negotiation between different communities</td>
<td>• Synthesizing proposals into design options</td>
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resultant spatial solutions were crystallized as two-dimensional maps, to assist with identifying and analysing their commonalities and differences. Post-action informal interviews were conducted with students and tutors, around the considerations and decisions that led to different solutions. Stakeholders such as major office towers and incubators in One-north were also interviewed, including officers from the JTC, the NUS Office of Estate Development, the Prime Minister’s Office (PMO) National Population and Talent Development Division, and the Singapore Science Park.

2.5 Planning site: Greater One-north creative city

Figure 1: Fragmented developments in Greater one-north

One-north was planned and developed as a knowledge-based industrial estate in Singapore to accommodate high-tech businesses and research institutions in biomedical sciences, info-communication, and media since the early 1990s when Singapore sought to move up the global value chain, shifting its economic growth from labour-intensive industries to technology- and knowledge-intensive industries. Its location took advantage of convenient transit node at Buona Vista and proximity to educational and research institutions, including NUS and Singapore Polytechnic. The original intentions envisioned high-density, mixed-used urban neighbourhoods, offering researchers, scientists, technopreneurs, and venture capitalists having an ideal environment for research and collaboration. A master plan was developed by Zaha Hadid Architects in 2001, and was implemented in part as of time of studio, in the area south of Buona Vista, including office buildings, campuses, and a few residential buildings. Some of the most recent developments include Launchpad@One-north in 2014, an incubator refurbished from flatted factories for light industries to house high-tech start-ups and ‘ensure that the innovation and entrepreneurship drive in Singapore would not rely solely on large research institutes’ (Phua, Prakash,
& Chia, 2018, p. 60). Its location just north of Science Park I partially completes the development along North Buona Vista Avenue, north of the Ayer Rajah Expressway (AYE). Most of the remaining land are greenfields or very low-density ‘black and white’ bungalows spread some distance apart from each other.

To maintain a good street-level connectivity in a high-density development, the first phase of One-north was designed as low-rise with building bases covering the whole plot with no or less setbacks compared with other similar streets in Singapore. Food and beverage shops were arranged in the pedestrianized area in blocks, and bridges in the sky connect all buildings of the first phase, allowing more interactions between different entities. The second phase of One-north took a more concentrated approach by housing all tenants and facilities in a single high-rise building complex (Fusionopolis), to facilitate a more vibrant lived-in community.

![Diagram of the area showing the physical barriers.](image)

**Figure 2:** The physical barriers

Although a variety of issues concerned the six teams, two planning challenges stood out. Despite the intentions to create an environment to ‘live-work-play-learn,’ insufficient dwelling units were constructed. New residential developments were expensive and separated from existing affordable housing at Commonwealth. Most workers commute from neighbourhoods beyond the planning site. The lack of housing meant that few people remained in this area after working hours, besides visitors to retail and restaurant outlets near Buona Vista transit station.

In addition, spatial connections within the area were constrained by major roads such as the dual-four lane Ayer Rajah Expressway (AYE), bridged by dual-one, dual-three, and
dual-four vehicular flyovers, and six pedestrian bridges. South of AYE was Kent Ridge, on which much of NUS was sited and part of which was developed as Kent Ridge Park, up to 61 metres above sea level. The limited number of existing public bus routes between One-north and other research areas does not address this fragmented development, neither do development-specific shuttle buses that serve internal travel demand to and from transit stations. All these served to increase commute time. These physical barriers pose considerable challenges to connect planned residential development along the southern waterfront on retired docklands.

3. Results

Based on common observations that the extant land use pattern created urban fragmentation and monolithic, monofunctional areas, which impaired the urban life of these areas, the teams proposed distinctive spatial plans, with permutations of monocentricity vs. polycentricity, limited vs. extensive 'air-rights' development across AYE, and a lower vs. higher residential-to-working population ratio as shown in Table 1, resulting in four urban futures which are detailed elsewhere (Hua et al., 2022).

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<th>Urban futures</th>
<th>Spatial network</th>
<th>Bridging the AYE</th>
<th>Residential to Working</th>
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<td>Monocentric</td>
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<td>Scenario A1</td>
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Briefly, futures A1 and A2 both feature one contiguous mixed-use area, invariably around the current Launchpad@One-north and Science Park I, decking over limited parts of AYE, e.g., between transit stations at National University Hospital (NUH) and One-north, or more extensively along a large stretch to enable a more contiguous urban fabric. The former resulted in the lower overall development density (similar to the University Town), whereas the latter featured a higher overall development density (similar to Fusionopolis). Their differences are best exemplified by the following spatial plans.

Figure 3: Possible spatial solutions in futures A1 (left) and A2 (right; notice proposed decking over AYE from University Town to Portsdown Avenue).

Correspondingly, futures B1 and B2 both feature multiple mixed-use areas of different hierarchies, with limited or extensive decking over AYE, to support transportation needs from lower or higher residential-to-working population ratios as shown in Figure 4. Besides the central core, there will be other subcentres across the site. Across the six proposals, these subcentres may be located near University Town, next to One-north, or towards Alexandra. The air-rights development over AYE is limited to the location of the centre and sub-centres in future B1 which expects a lower resident-worker ratio and a
lower development density (comparable with University Town or Fusionopolis). In an extreme case of future B2, the entire AYE between University Town and Alexandra may be built underground. The overall development density is the highest in this scenario and may be similar to downtown Singapore.

Figure 4: Possible spatial structures in futures B1 (left) and B2 (right). Notice location of centres along green (and blue) connectors.

4. Discussion

We now turn to analysing possible economy-ecology outcomes in these resultant spatial plans/structures using interpretive visual analysis, supplemented by observations and conversations with the student planners. Scenario A1 was driven by the economic intention of creating a vibrant linear urban core along Buona Vista Avenue, connecting the north and the south across AYE. Student planners were very aware of site-specific challenges to meet increased transportation needs of future residents, and sought to minimise the introduction of additional commercial uses for which additional residences will be required to meet the minimum 1:1 residential-to-working population ratio. As such, the approach was to strategically introduce commercial uses at the most critical points to connect the transit and commercial node at NUH with existing commercial developments along North Buona Vista Avenue. The concentrated commercial corridor likely supports vibrant night life and may serve as focal points for interactions and knowledge exchanges across job types in Greater One-north. Knowledge spillovers likely occur, but separate from greenery.

These economic-driven decisions of minimal but strategic change to improve urban life led to the retention of large swathes of existing greenery. However, the current patterns of green space use likely remain unchanged. Inherent in this spatial plan is the position that development is generally detrimental to the environment, and should thus be minimised while prioritising urban vitality. Student planners are pragmatic and cautious (but possibly realistic) in their estimation of their abilities to effect change. The implementation approach is incremental and with preference for shorter planning time horizon.

Scenario A2 addresses the same north-south fragmentation with greater gusto, resting on the assumption that improvements in engineering and construction technologies (and air-rights development) will allow minimal encroachment into greenfields while improving urban vitality. Careful introductions of built elements into green areas create opportunities for landmark developments, and efforts are made to introduce green and blue areas as connectors or focal points in otherwise built areas, including those on the AYE deck. Despite the higher density achievable through this spatial plan, it is easy to imagine greater human-nature interactions, and the possibility of casual relationship-building and knowledge exchanges along the green corridor on the way home, which may be brought to nearby restaurant outlets or landmark spaces. One may just as easily move to larger green
spaces further along the green corridor for immersive nature experiences to reduce cognitive load (Gan, Zhang, Ng, 2021).

This technology-enabled solution strikes a visionary balance to achieve both intensive urban development and opportunities for human-nature interactions. The high-quality environment, including ‘active’ and ‘passive’ greenery, serves to support knowledge spillover and KC development. Inherent in this spatial plan is the position that development is not necessarily detrimental to the environment, and that good quality high-density urban developments are possible. Student planners are thorough but optimistic in their estimation of planning and technology to effect positive change. The implementation must be phased, likely with a long-time horizon. Fine-grain planning and careful urban design guidelines, land parcellation, and effective development control will be required.

Scenarios B1 and B2 both featured the use of green (and blue) corridors for transportation, and sited their multiple urban centres at nodal points along their intersections. It is noteworthy that both of these spatial plans remained more schematic, suggesting that more effort may be required to imagine how these spatial structures may be realised. Regardless, their urban visions were clearly communicated in other drawings. Whereas B1 imagines well-distributed commercial and residential functions along three urban-nature spines flanked by larger green or blue corridors for active use or relaxation, B2 emphasizes the mixing of retail, office, educational, residential, and logistic functions across all of its polycentres, each with different characteristics. Greenery, both natural and man-made, serves to add urban character.

These conceptual solutions may or may not espouse similar values towards greenery and are idealistic in different ways (Chiaradia, Sieh, & Plimmer, 2017). Their orientation towards the economy-ecology dichotomy is unclear (or they may assert the absence of dichotomy). Both are premised on the possibility of a high degree of harmony between nature and humans who would live apart from or in nature areas. Whereas the former treat natural green spaces differently from man-made green spaces, the latter does not. The former evokes idyllic rural lifestyle in an urban work environment, while the latter necessitates large swathes of high-density development to finance the decking over of the whole AYE, which may be arguably beneficial for the environment elsewhere through intensive developments here. If these urban visions and spatial structures are to be implemented, much more careful planning and zone-based detailed guidelines may be required.

5. Conclusions

This study used action research-by-design to examine economy-ecology outcomes in different spatial plans given the same planning context. Different economy-ecology orientations may shape spatial planning profoundly, resulting in different economy-ecology outcomes that may or may not support KC development. In detailed spatial plans, two types of economy-ecology synergies may be identified, i.e., intensive developments to minimise ecological impact (synergy by separation, e.g., A1), and connective spatial design for socio-ecological encounters (synergy by encounter, e.g., B1). The four scenarios with different orientations toward the economy-ecology dichotomy illustrate these synergies to varying degrees. Their varying development densities alone do not provide sufficient indications. High quality environments (e.g., A2) are synergistic in both ways. Simultaneously centring people and nature may be necessary to attract talent and accelerate innovation in knowledge cities.

Contributor statement

DRYG, XH and RS co-conceptualised the book-length project from which parts of this paper are drawn. XH curated the initial manuscript draft and visualizations (Figures 1 & 2). DRYG conducted additional analysis. XH validated these analyses. RS provided supervision and project administration. JR obtained funding and resources. All authors participated in the review and content editing of the manuscript.

Acknowledgments

The authors thank the JTC Corporation for funding this studio-based study, and for providing constructive critiques of NUS Master of Planning (MUP) student works. The funder was not involved in the subsequent manuscript conceptualization and analyses. The authors also wish to thank Palak Mehta for assistance with data curation, NUS MUP AY2018/19 student participants, and tutors namely Pablo Viejo, Frank Eisenmann, and Jürgen Rosemann.
References


