

Evolution of Industrial Landscape in Singapore

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“In a rapidly changing world, we cannot anticipate all our future needs. Our best laid plans will have to be modified and updated as new challenges emerge. Hence, JTC must remain dynamic and nimble, keeping an eye on business trends, and responding promptly to new threats and opportunities.”

- *Prime Minister Lee Hsien Loong (June 2008)*

Introduction

Set up in 1968, JTC Corporation (JTC)'s key task was to develop Jurong Industrial Estate into an integrated manufacturing hub. Jurong Industrial Estate was the centre of Singapore's industrialization drive which provided jobs for the fast growing population and reduced Singapore's reliance on entreport trade. However, reclaiming crocodile-infested swamps in Jurong in the 1960s for factories that might not come to Singapore was an act of faith. Many at that time considered it a foolhardy exerciseⁱ. A hilly, jungled area mostly covered by mangrove swamps who many called the “lost region” in the west of Singapore, Jurong was selected as the location for the first industrial estate of Singapore. Its founding father, Dr Goh Keng Swee's vision for Jurong was to be the birthplace of large-scale industrialization in order to shift Singapore's economy to higher gears.

High unemployment combined with pressing needs to create a conducive environment for growth and investment resulted in unique solutions that were tailored to meet the needs of Singapore. Pre-independence, Singapore's economy had been heavily dependent on the entreport trade and the then British expenditure at the naval bases on the Island. Post independence, a national drive towards industrialization was launched to promote economic growth. The objective was for jobs creation and was prompted by the growing awareness that Singapore's labour force was growing faster than the expansion in the entreport trade. The administrators were faced with the twin task of creating maximum number of jobs in the shortest possible time to arrest the rising unemployment; and to achieve within the shortest possible time, the diversification of the economy. JTC's challenges were multifold and it was for this reason that JTC was tasked with the planning, development, leasing and management of industrial estates in Singaporeⁱⁱ.

The 60's –

In the 1960's, Singapore attracted labour intensive industries and provided ready-built standard factories to facilitate speedy set-up for the companies. Economic growth and job creation was seen in quantitative terms in the number of jobs that could be created and the amount of foreign investment that could be earned due to this. Two distinct form of industrial environments emerged during this time:

- (i) The first is that of well-planned large industrial estates in the rural/suburban parts of the island: and
- (ii) The second form is that of planned light industrial estates located close to high-density housing estates or at the fringe of the central area.



Figure 1: Designed for mass replication (Source: JTC)

The 70's -

The 1970's was in essence a continuation of the efforts of the 60's to achieve sufficiency in terms of economic growth and eradicating unemployment. Petroleum refineries and petrochemical industries were identified as key growth sectors to push the economy further and the offshore islands off Jurong Industrial Estate were identified to locate these companies.



Figure 2: Essential and quality products (Source: JTC)

The type of industrial estates being developed took a different form:

- (iii) Industrial estates with clusters of industries like furniture and shipyards. The creation of such industries was also the result of government policies such as the relocation of pollutive industries from the water catchment areas.
- (iv) Setting up of workshop complexes to house smaller industries.



Figure 3: Landed factories (Source: JTC)

The 1980's –

The 80's saw an industrial restructuring program, the prime objective which was to develop Singapore into a modern industrial economy based on science, technology, skills and knowledge. This saw a shift to capital and technology intensive industries with a better-trained work force and higher industrial capabilities. To support and meet the needs of new businesses, the type of industrial parks that evolved took a new dimension:

- (i) Upgrading and improvement of industrial parks through new product creation; and
- (ii) Birth of Science Parks and later Business parks in Singapore. These parks are set in high quality environments catering to the needs of modern businesses.

To name a few, the Singapore Science Park and the Tuas Biomedical Parks were two such ambitious master plans that were initiated to cater to high end knowledge based industries.



Figure 4: Ramp up, Stack Up Factories – Land scarcity + intensification (Source: JTC)

The 1990's –

The birth of the information technology age saw many businesses moving up the value chain by intensifying their use of information and related new technologies. Advancement in technology also meant addressing new business expectations, needs and demands and JTC had to find ways of keeping up with the rapid nature of evolving business needs. This period saw the organizations strategic shift to becoming more customers centric, business oriented and internationally driven. JTC was evolving to becoming a 'partner' to businesses from its traditional role of being a land infrastructure provider.



Figure 5: High Value add industries: Jurong Island (left) Changi Business Park (right) (Source: JTC)



Figure 6: International Business park, 1992 (left) Changi Business Park, 1997 (right) (Source: JTC)

Land intensification: Reclamation, En-Bloc Redevelopment and Higher Plot Ratios

The year 1991 saw Singapore complete its concept master plan to determine the ultimate land bank required. To ensure that land resources would be sufficient for future industrial growth, policies and plans placed emphasis on both land preservation and land-use optimization. Accordingly, JTC implemented a major land acquisition programme to accumulate its land bank. On top of these changes, land reclamation works were also carried out on a much larger scale to increase the supply of industrial land. Previously, land was reclaimed to create today's Jurong Industrial Estate in the 1960's and 1970's, including two sea channels for offshore and marine industries. From 1993 onwards, Jurong Island, Singapore's chemical and energy hub located off the west coast, was created by amalgamating a cluster of seven separate islands through land reclamation works.ⁱⁱⁱ

In addition, under JTC's 1997 Industrial Plan for the 21st Century (IP21), policies were drawn up to maximize the industrial land yield through intensification of industrial land namely through higher plot ratios. For new companies, a satisfactory plot ratio of their building facility had to be fulfilled before granting the lease of land to them. Existing industrial companies were encouraged to increase their plot ratio through incentives such as lease extension, and rules were reviewed to allow the return of under-utilized excess land with minimal cost, and to allow greater flexibility in subletting spaces held for future expansion.^{iv} In addition, JTC set up the Redevelopment Group to carry out en-bloc redevelopment schemes for old estates identified as not optimally using the land, usually with very low plot ratios of less than 0.5. The Group purchased back the unexpired tenure of leases and provided compensation packages to help these tenants relocate. Besides rebuilding these low-rise factories to high plot ratios, the infrastructure and facilities of these estates were improved to match up to the needs of modern industries that the country was moving towards. These redeveloped units were then allocated to higher value-added companies that helped achieve higher land productivity compared to their former tenants.^v

JTC also sought pragmatic ways to work around the challenges of conventional industrial operations. The stack-up factory was a new building typology that JTC came up with, designed to intensify land use by stacking the traditional standard factories on top of one another to create multi-storey factories. The use of ramps to gain access to upper levels allowed occupants to enjoy the same convenience as those at ground floor with regard to loading/unloading of goods. The first stack-up factory built achieved a plot ratio of 2.05 at 3 levels high, as compared to 0.8 for previous low-rise factories, thus allowing each unit of land to be put to use to its full potential to stretch the supply of land.^{vi}

Quality Industrial Facilities: Business Parks and Specialized Industrial Clusters

The economic development strategy of Singapore expanded in the 90's to encompass the service sector in addition to manufacturing, with the two as the twin driving force for growth in the economy. The latter remained an important source of growth, contributing to 23% of the country's GDP in 1997. Meanwhile, the National Technological Plan called for a shift towards higher value added, competitive industries such as biomedical science and wafer fabrication.

Putting this in the context of industrial land policies, increased land productivity was sought by allocating land to suitable industries. The shift towards these less capital-intensive light industries, for instance product design, software engineering and other technology-based activities, thus prompted a new zoning category for Business Parks as the industrial landscape transitioned towards well-developed estates with conducive environments. These industrial estates not only sought to meet the functional needs of companies, but also enhance the identity and quality of the built environment. Besides building upon land intensification efforts to achieve plot ratios as high as 2.5, new elements of planning and design were introduced, such as design and landscaping of public spaces, and provision of amenities. International Business Park, launched in 1992, dedicated 20% of the land area to open spaces, with lush greenery, water features and public spaces scattered across the estate. The Atrium was an amenity centre centrally located in the IBP. These thus helped to create an environment that facilitated creative work, particularly for image-conscious companies. Five years later, the Changi Business Park, developed to provide spaces for companies dealing in central distribution, inventory control, freight management and high-tech manufacturing, was planned with a central green spine infused with water features and public art, and other dedicated spaces like sky gardens.^{vii viii}

In order to facilitate the taking flight of new industries, JTC spearheaded the development of specialized industrial parks and estates that took on various forms, depending on the specific niche needs of these industries. Thus began JTC's journey as Singapore's industrial infrastructure provider, which has proven to be instrumental in attracting and securing private investment to grow new industries. Besides being particularly relevant for location-specific industries like the offshore and marine and aerospace industry, concentrating and integrating companies within same industry together allows economies of scale to be reaped from commonly shared infrastructure tailored closely to the type and scale of production needs of each cluster. This also helped to augment the aforementioned goal of land intensification by shrinking unnecessary land taken up by transportation and storage. As such, many of JTC's projects have looked to capture such synergistic interaction through industrial clustering, for instance Tuas Biomedical Park, Woodlands Wafer Fab Park, Advanced Display Park, paving way for more sophisticated cluster models for the next decade.

Jurong Island exemplifies industrial clustering principles employed by JTC. The island is planned and developed with well-established infrastructures that allow companies to 'plug and play', bringing about cost savings. Due to the nature of the industry, it is important to address security and safety issues through relevant infrastructure, for example with a barging terminal to allow ease of goods transportation. Common-shared facilities (e.g. training centres, amenities, security, fire stations and other essential services) allows resources to be pooled together and used more efficiently. Also, synergies between companies are enabled through carefully planned cluster arrangements to allow them to be closely linked together, such that one's output can be quickly and easily transported to another as an input. The Banyan LogisPark housing chemical logistics companies located on the island is an example of such a relationship. This clustering strategy also helps to achieve land intensification through saving of land space.^{ix}

The 2000's –

The turn of the century was an important phase for the organization as it was corporatized with a new brand image and an office like modern headquarters facility that

was more customer-friendly and business-like to keep up with the modern times. This period also saw JTC promoting more knowledge based and technology intensive industries.

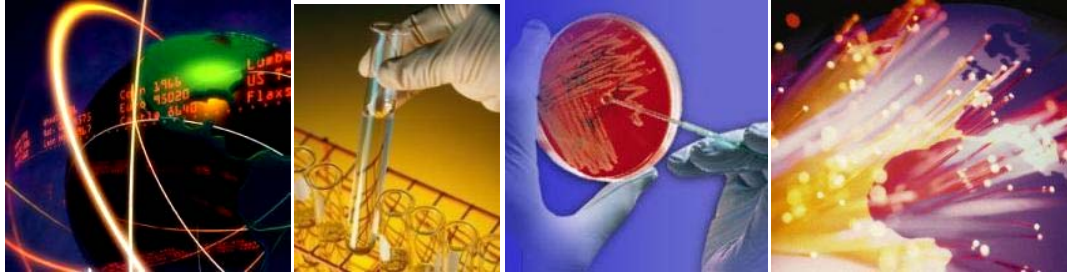


Figure 7: Knowledge based economy (Source: JTC)

Integrated Masterplanning: Work-Live-Play-Learn

By the millennium, the path towards a full-fledged and thriving knowledge-based economy was clearer and nearer than ever. As Singapore's manufacturing sectors made their way up the value chain to increasingly sophisticated industries, economic planners set out to steer industries towards R&D, ICT, and other innovation activities. The fundamental principles of land intensification, industry clustering and quality work environments adopted in the 1990's were taken further to guide consequent industrial developments.



Figure 8: One - North(Source: JTC)

The 200-ha one-north estate began its 20-year phased development in this decade to house a cluster of world-class research facilities and business parks. Industries housed at one-north fall into the 'Super-Creative Core' category as termed by Florida, with the biomedical R&D cluster at the area known as Biopolis, physical sciences and engineering R&D and ICT at Fusionopolis, media hub at Mediapolis and training and talent development centre at Nepal Hill. The modern high-rise buildings at one-north can be considered as a microcosm of a cluster, with firms of various sizes within the same industry supporting each other and sharing common facilities. In order to attract talent, attention was also paid to providing amenities catered to the needs of white collar working professionals, with residential options offering a high quality of life for the creative community working at one-north.

Vibrant Industrial Spaces: Mixed-use and Urban Design

In the 2000's, JTC modified its mission from delivering not just quality industrial facilities but also creating vibrant industrial spaces that redefined the perception of Industrial Planning and the significance of Urban Design in its estates. At one-north, Vista Xchange area was designated as a highly mixed-use lifestyle, business, hotel, entertainment and transport hub, playing the role as the corporate and business support cluster for one-north, and envisioned to promote a vibrant, dynamic atmosphere.

One-north was also the pioneering project under which Detailed Planning Design Guidelines were put in place for JTC's industrial estates. A high level of urban design was emphasized throughout the one-north estate. Urban parks and spaces beautified by greenery were important features to complement the activities of the community and industries. The one-north Park spanning 16ha across the estate was designed with landscaping features that visually complement the buildings. Other spaces include epicenters of each cluster, and semi-private spaces like sky gardens, all of which has its own multi-functional purpose as places of respite or activity-generating venues. Some of these spaces were a result of efforts to conserve suitable buildings and trees of heritage and convert them into compatible uses.

The 2010's –

The 2008 Master Plan heralded a change in land-use zoning for industrial land, with the creation of Business 1 (B1) for light industries and Business 2 (B2) for heavy industries, Business Park zones, and White zones for each of the three where mixed-use developments are encouraged. ^x Building upon this, JTC established a classification system to differentiate between the type of its industrial estates in terms of the nature of the industry, land use and urban design that would thus shape the physical environment. Namely, cutting-edge industrial estates are placed in Category 1, light industrial in Category 2, and generic or heavy industrial in Category 3, with the proximity to population nodes, level of mixed-use and urban design guideline enforcement decreasing from Category 1 to 3. This categorization system completes the picture so far of the different types of industrial landscapes in Singapore today.

Land Intensification Innovation

As part of land intensification strategy to sustain land supply, JTC turned to new, cutting-edge methods, such as basement or deep underground developments to create more

spaces within the same plot of land. The almost completed Jurong Rock Caverns on Jurong Island, Southeast Asia's first underground liquid hydrocarbon storage facility going as deep as a 9-storey building, has helped solve problems of oil storage and made available land for further industrial expansion.^{xi} Offshore, possibilities of using Very Large Floating Platforms as oil and petrochemical storage facilities are being explored. At Lorong Halus, the previously landfill site is planned for rehabilitation into usable space to house an industrial park. To facilitate such innovation efforts, a joint research centre between JTC and the Nanyang Technological University was set up to engage in R&D in industrial infrastructure, including reclamation and underground works.



Figure 9: Lorong –Halus (Source: JTC)



Figure 10: Jurong Rock Caverns (Source: JTC)

Besides building downwards, the drive towards more sophisticated and smart solutions with regard to industrial building typologies was accelerated to allow companies to build higher and utilize available space optimally. Studies for an industrial complex serviced by mega-hoist system and cargo lifts and expected to reach plot ratio of 3.0, and save 2.4ha of land are currently being done. Another interesting idea is the modification of terrains to enable the 2nd storey of factories to have raised vehicular access.



Figure 11: The CICM (Complex industrial complex Mega hoist)(Left) and Plug & Play Factories (right) (Source: JTC)

For specific industries, cluster hubs were proposed as a variation of clustering within an area. The Surface Engineering Hub meant for electroplating companies is planned to be a multi-storey and multi-tenanted building that taps on advantages from housing firms belonging to the same value chain in the same location. Similarly, the Med Tech hub is targeted to reach a plot ratio of 2.5 to serve the fast-growing medical technology sector. Essentially, the clustering concept in industrial parks has been shrunk down and embodied in one single building.



Figure 12: The Med – Tech Hub (Source: JTC)

Dynamic Industrial Spaces: Shaping Industrial Communities in New Estates

In the recent years, JTC has continued its role as a world-class infrastructure provider and estate developer in its industrial clusters. As explored above, industrial estate planners have taken industrial clustering to the next level by coming up with new forms of clustering that are not necessarily confined to the traditional spatial concentration of similar industry firms in a particular location. Similarly, such innovation continues for new industrial estates delving into new industries that Singapore is looking to go into. By acquiring a comprehensive insight into the nature of the industry value chains and the operations of its companies, industrial infrastructure within estates are shaped to provide the physical 'framework' within which each company is enabled to generate synergies among themselves to form a tightly-knit industrial community with a competitive edge.

In addition to the use of urban design to create desirable industrial workspaces, distinctive identities were created for its new industrial parks. By fashioning a particular image for these parks that differentiates itself from industrial locations in the rest of the world, JTC was able to brand its parks and promote its industrial spaces to attract global industrial players to see Singapore as a choice investment location.

Figure 13: Paya-Lebar iPark – Creating desirable Industrial Spaces (Source: JTC)

Seletar Aerospace Park (SAP) is a good illustration of this dual strategy of cluster synergies and place-making. Currently in its third and final phase of development, the estate will have a General Aviation Centre for training and smaller aircraft maintenance to save costs for firms following a consultation session with aerospace companies^{xii}. In addition, planners built upon Seletar Aerospace Park's heritage as an airbase during British Colonial times, and paid deliberate attention to the preservation of existing colonial houses and other structures, and native trees that pays tribute to its history and contributes to SAP's unique character.

Figure 14: Seletar Aerospace Park (Source: JTC)

CleanTech Park (CTP), positioned as an eco-business hub for clean technology R&D test-bedding and commercialization, seeks to incorporate environmental sustainability

and conservation practices into the built environment of the estate. Clustering dynamics here are exclusive to CTP in a way that individual firms are intertwined into a community where they have a stake in shaping a sustainable industrial ecosystem through its operations and products. Also, features such as sky trellises, green spaces, cycling and pedestrian networks at CTP, not only serve functional or aesthetic purposes, but also embody the idea of internal activities and ethos of CTP firms being reflected in the overarching principles of the development.^{xiii}

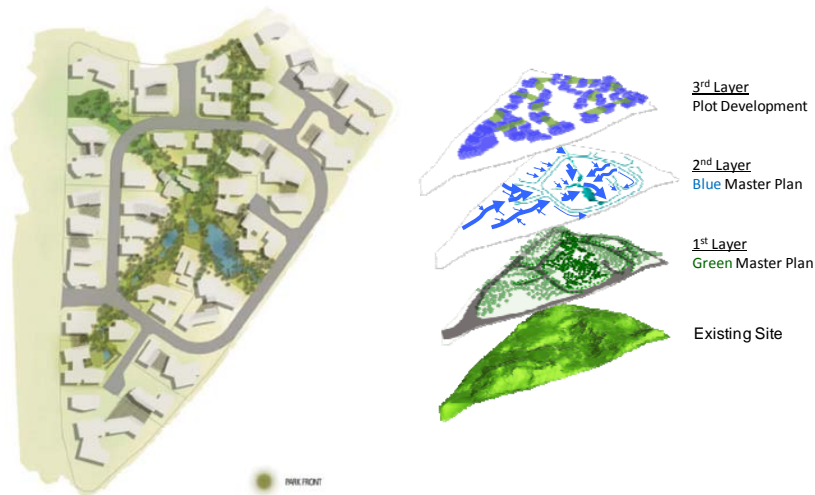


Figure 15: Clean-Tech Park (Source: JTC)

Conclusion: JTC as a strategic developer and Industrial Infrastructure Innovator

In tracing the years of evolution of industrial landscape in Singapore, it can be observed how each decade's economic and land policy mechanisms combined with physical planning and urban design initiatives have influenced the focus in planning and design principles of building and estate typologies, and the delivery processes of JTC's industrial developments. As such, the end result of the physical form as well as the interaction and functioning of Singapore's industrial estates have seen a progressive transition from the past till now, with each decade adding on a new dimension to the industrial built environment in Singapore.

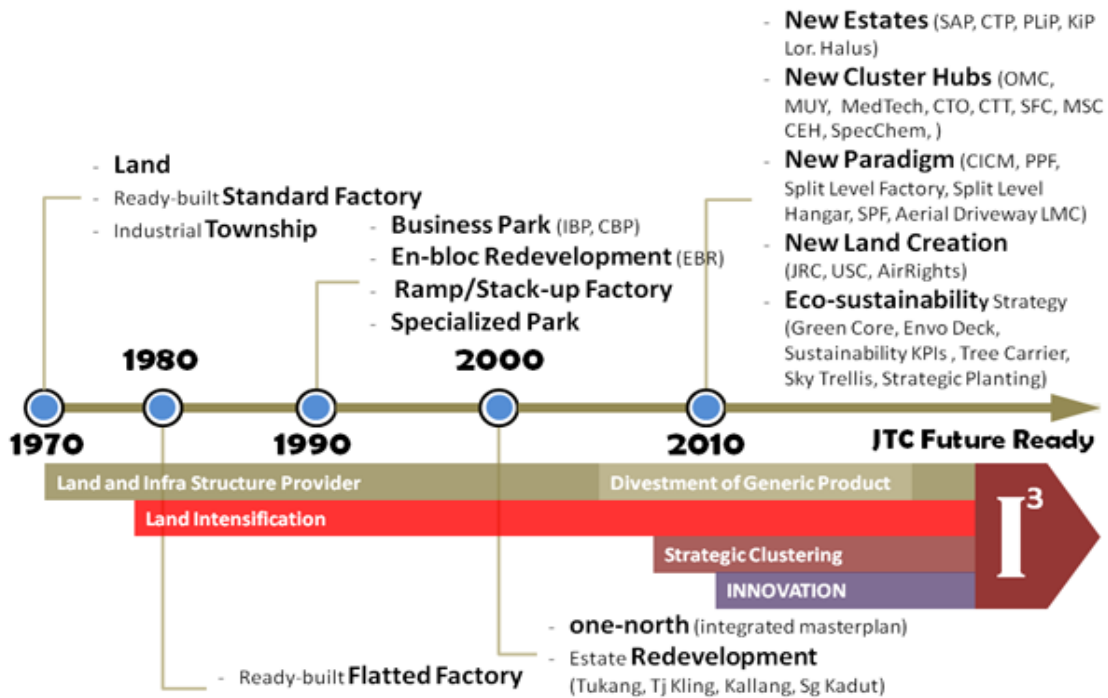


Figure 16: JTC's role and evolution over the years (Source: JTC)

Through the years of evolution of industrial landscape in Singapore, from being a Land Infrastructure provider, JTC's role as the principal statutory board for industrial development has constantly evolved. Today, JTC is seen as a strategic developer of cutting edge industrial spaces bringing forth new paradigms in industrial planning and Urban Design. In order to constantly build investor's confidence and attract businesses to Singapore, JTC's takes upon itself, the responsibility of being the first strategic developer of its new industrial estates. Leading by example, JTC builds never-before-attempted infrastructure like the Green Core of the Clean Tech Park that provides vistas and presence of green landscaped park terrains in a Business Park setting. JTC has also taken the position of the 'industrial infrastructure innovator' whereby it aims to create infrastructure that is future ready to stay one step ahead of its competitors and continue to be an attractive regional as well as international location for investments and businesses alike.

To meet the demands and expectations of a country that constantly wishes to reestablish its presence in Asia, industrial development is seen as a primary driver and tool to accomplish this aspiration. In the coming years, industrial development for Singapore will remain as relevant to its growth as it was when it first started 40 odd years ago and JTC will continue to seek newer avenues and newer methods to meet the expectations of investors as well as continue to create meaningful jobs for its workforce.

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