數據應用
推動市區更新
Fuelling Urban Regeneration with Big Data

日常生活中,相信大家對以下情景都不會陌生:只要上網搜尋過某城市的旅行情報,網站或社交平台便會自動顯示相關目的地的酒店廣告;驅車趕路時,當開啟衛星定位功能,地圖手機應用程式的即時路況便能告知哪裡有塞車……這些便利和貼心的資訊提供和服務的背後,原是基於不同數據如網站瀏覽歷程或行車定位等的運算與分析。

時至今天,大數據(Big Data)已不只應用於提供創新服務上,更在企業和公共機構的決策過程中,擔當了舉足輕重的角色。在市區更新方面,市區重建局(市建局)多年來一直以大量資料和數據輔助,來策劃及落實各項市區重建任務。隨着數據應用愈來愈重要,市建局近年亦銳意提升資訊基礎設施和引入嶄新的應用程式和系統來加強數據管理及應用,當中包括建立一個以地理信息為基礎的「市區更新資訊系統」(Urban Renewal Information System),以及積極將「建築信息模型」技術 (Building Information Modelling) 應用在不同範疇的工作中,務求在促進效率之餘,更能作出以數據為本的決策,以智慧推動市區更新,創造出可滿足市民所需的優質生活環境。

正因數據應用無遠弗屆,能在海量的資訊中提煉出有意義的數據再加以運用,便如鑽探到新石油。在Data is the new oil的今天,就讓《建聞》帶大家了解大數據如何為市建工作注入源源不絕的動力,成為推動市區更新的新能源。

In an ordinary day, you search the internet for travel information of a particular city, and subsequently advertisements showing hotel information about that city pop up whenever you are online browsing websites or social media pages. While you are driving, your in-vehicle mapping application enabled by the Global Positioning System (GPS) automatically displays real-time traffic information and advises you the route to avoid traffic jams. Thanks to technologies and the algorithm for analysis of various types of data – such as web browsing history and GPS data in the above cases, the emergence of these clever and user-friendly gadgets have brought convenience to our daily lives.

Today, 'Big Data' not only serves to provide a wide range of innovative tools and services but also plays an indispensable part in the decision-making process of many corporations and public organisations. In implementing urban regeneration plans, the Urban Renewal Authority (URA) has long been utilising vast amounts of data and information to facilitate its project planning and works management. As the use of data gathers momentum, the URA is determined to strengthen its capabilities in data management and usage by upgrading its information infrastructure and introducing innovative applications and systems. These include the setting-up of a geographic information-based Urban Renewal Information System (URIS) and the active employment of Building Information Modelling (BIM) technology in its various aspects of work, with an aim to enhance efficiency and facilitate data-driven decision-making process for attaining smart urban renewal and quality living environment that can address social needs.

As the application of data knows no boundaries, extracting and processing insightful data from the massive sources is as valuable as mining new oil fields. In today's world where data is the new oil, "Connect" will take you to a closer look at how big data can become a new source of energy for fuelling and sustaining urban renewal.

「市區更新資訊系統」
以數據為本　驅動市區更新決策

Urban Renewal Information System (URIS)
Helps Attain Smart Urban Regeneration with Data-driven Decisions

在籌劃市區重建項目時，市建局一直利用大量數據，輔助規劃和建築設計的工作。

In implementing urban regeneration plans, the URA has long been utilising vast amounts of data and information to facilitate its project planning.

「任何東西只要有位置，就可成為具有地理資訊的空間數據（spatial data），能化成圖像作進一步分析，甚至可以三維或四維地圖的方式呈現，其所描述的，勝過千言萬語的形容。」市建局規劃及設計經理林少華（Edmond）如是說。

Edmond精通地理信息系統工程（Geographic Information System — 簡稱GIS），曾經參與開發水務署供水設施管理系統、漁農自然護理處的郊野公園資訊系統，以及運輸署的智能運輸系統等工作。涉獵過不少基建資訊系統的他表示，一個地方若要做好城市管理，必須掌握GIS，將數據空間化及以地圖方式呈現出來，這樣所有細節和問題才能一目了然，方便規劃、管理和解決。

"Spatial data, which define any location on earth, can be conveyed in digital maps for analysis, or be presented in different forms of imagery including three-dimensional or four-dimensional maps conveying details that are worth more than a thousand words," said Mr Edmond Lam, Planning and Design Manager of the URA.

A Geographic Information System (GIS) specialist, Edmond has wide experience in developing various GIS systems including the Digital Mapping System for the Water Supplies Department, the Country Parks Information System for the Agriculture, Fisheries and Conservation Department and the Intelligent Transport Systems for the Transport Department. From his experience, he knows there's one thing integral to the effectiveness of city management – a full grasp of GIS technology which can help present complex city data in a map context that could facilitate urban planning and design, as well as city management.

這樣的科技輔助，對牽涉範疇極廣、策劃過程中經常要參考和處理大量不同數據的市區更新工作而言，可謂份外重要；尤其在籌劃市區重建項目時，愈能搜集、整合和分析更多有用數據，便愈有助得出更人性化、更以人為本的規劃和建築設計。為此，市建局正著手建立「市區更新資訊系統」(URIS)，期望將不同來源和類別的數據，如市區土地用途、地區規劃、發展密度、道路網絡、基建及社區設施、樓宇狀況、人口分佈、商業營運等資料儲存和整合起來，再加強界面和各項應用功能，幫助同事處理和分析不同規劃資料。

Edmond舉例說，當同事為重建項目進行第一階段社會影響評估時，日後只要利用URIS便可輕易摘取項目內及附近的統計處人口結構數據，及來自地政總署的政府、機構或社區設施如老人院、幼稚園等資料，以及公共空間的分佈，從而分析項目對社區的影響。此外，從市建局凍結人口調查所得來的住宅租戶數據，亦可拿來與房委會及房協預留給遷置戶的公屋單位數據配對，有助擬備遷置的措施建議。這樣的新系統應用功能，比起以往只能以人手整合不同數據，無疑更能加強空間分析能力，輔助市建局制定更全面的市區重建方案。

在URIS下，不同種類的規劃資料除可以透過2D平面地圖輕易整合和分析外，它的另一賣點，是擁有以三維（3D）地圖顯示空間數據的能力。Edmond表示，

Edmond說要做好城市管理，必須掌握地理信息系統工程(GIS)。
A full grasp of GIS technology is integral to city management, said Edmond.

For urban regeneration, the adoption of such technology is especially crucial as it involves the collection, processing and analysis of vast variety and amount of data. The more useful data the URA can gather, consolidate and analyse, the greater the capability of it to attain people-centric planning and architectural design. To this end, the URA is embarking on the development of the Urban Renewal Information System (URIS) that would standardize and consolidate a wide range of data from different sources such as the Outline Zoning Plan, Territory Planning Unit/Street Block plan, road network, infrastructure, community facilities, building condition, population distribution as well as trade mix activities and so forth, into an integrated database. Together with a suite of user friendly visualization and smart analytical tools, the URIS will help boost the URA's capability and operational efficiency in implementing urban regeneration under the 5R strategies.

Citing the work of conducting "Stage 1 - Social Impact Assessment for redevelopment projects" as an example, Edmond said in future, relevant data including demographic data from Census and Statistics Department, information on government, institution and community facilities from the Lands Department including details of elderly centres and kindergartens, as well as the distribution of public spaces can be available simultaneously at a few clicks in the URIS for assessing impacts of the project on the community.

Furthermore, with the support of URIS, the rehousing process for affected tenant is likely to be streamlined in the future by matching primarily the rehousing preference of tenants gathered from the URA's freezing surveys, with data of public rental housing units allotted by the Hong Kong Housing Authority and Hong Kong Housing Society. Outperforming the previous manual process of data consolidation, URIS will greatly enhance the URA's spatial analytical capability allowing the formulation of more holistic plans for urban redevelopment.

In addition to integrating different planning data in 2D maps for analysis with ease, URIS also enables the visualisation of spatial data in three-dimensional maps. As pointed out by Edmond, the creation of 'Digital Twin', which refers to the digital replica of a real-world city landscape, sets the trend for formulating smart city blueprints in the world. Through this virtual representation, city governments are able to keep themselves abreast of real-time data such as air quality, water and power usage, traffic condition and others from the physical world. With the assistance of artificial intelligence technologies and other predictive analytics tools, decision makers can put their models to tests, and the results generated would be conducive to achieving better city management and more sustainable environment.
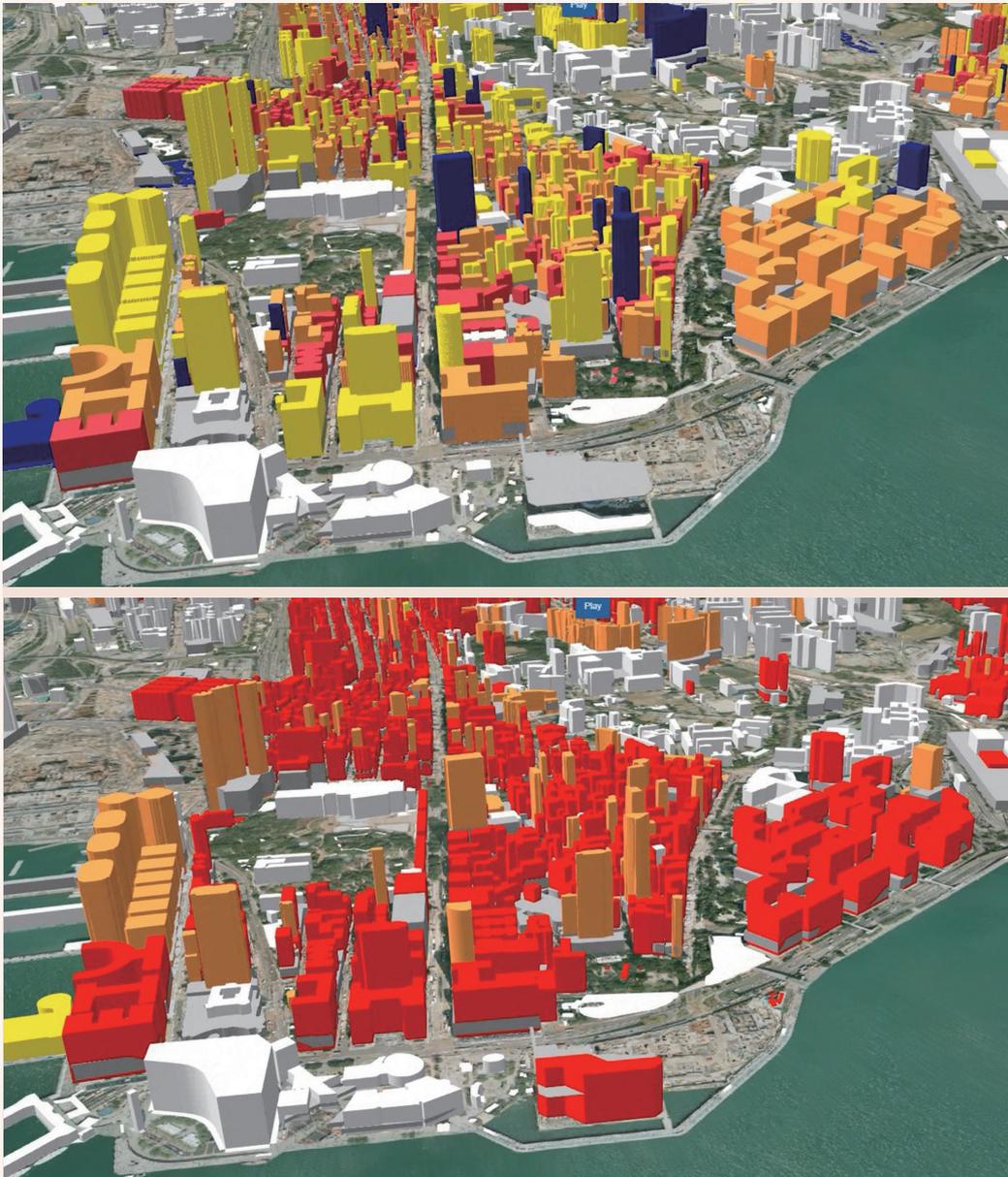
3D UR Planner從數據庫中摘取大廈樓齡資料，模擬市區在2019（上圖）年及2046年（下圖）的老化情況，有助進行市區更新規劃。紅色建築物顯示其樓齡為超過50年；其他以橙、黃和藍色標示的建築物樓齡分別為超過30年、超過16年，以及16年或以下。

With buildings age data, 3D UR Planner can help with better planning of urban regeneration works by simulating different scenarios of urban decay in 2019 (upper photo) and 2046 (lower photo). Building blocks in red are those aged above 50 years. Others in orange, yellow and blue represent buildings which are over 30 years, over 16 years and those aged 16 years or under respectively.

要建設智慧城市，創建Digital Twin（數位孿生）是全球趨勢。所謂數位孿生，是指在數碼環境中創建出一個能與真實城市環境同步的「雙胞胎」，透過這個虛擬分身，決策者能掌握現實世界中的實時數據，持續分析，並透過模擬及人工智能輔助，了解所監測的設施或環境可能產生的反應、狀況或是效能等，從而有助得出更適合居民的城市設計和管理，以及更有效能的綠化和環境措施。

為此，市建局開展研發三維智慧數碼地圖（3D iMap），並正在建構出原型（prototype）以作測試。Edmond說，未來3D iMap可包含不同空間數據，例如屋宇署

In light of this, the URA has embarked on a pilot project to develop the 'Three-Dimensional Intelligent Map' ('3D iMap'). Edmond explained that the '3D iMap', having consolidated different types of business data, such as buildings information from the Buildings Department, property valuation data from the Rating and Valuation Department, property transactions and ownerships from the Land Registry, as well as buildings condition information gathered by the URA, is capable of showing various kinds of data of respective building units in a three-dimensional setting. Should owners wish to carry out building rehabilitation work, buildings data such as external walls area and hence relevant work estimates will be immediately available at '3D iMap', thereby saving much time and efforts.

的大廈建築資料、差餉物業估價署的大廈單位租值數據、土地註冊處物業業權的資料，以及市建局在樓宇復修調查中所得的樓宇狀況資料等等。在應用方面，他舉例說，由於三維數碼地圖結集了不同大廈的建築資料，若業主日後想參與樓宇復修，同事只要按幾下鍵盤，便可計算出如大廈外牆面積等數據，從而初步估計到翻新外牆所需的預算費用，快捷省時。

此外，URIS還有另一項應用工具3D UR Planner，可讓規劃設計師及建築師以立體地圖影像，進行一些三維空間的研究。例如在舊樓林立的街道網絡中，如何預知新項目設計有否影響周邊的日照？單位的景觀是否開揚？這個三維的規劃工具可以從不同的地點，模擬視域結果並加以分析。而當3D UR Planner從數據庫中摘取如大廈樓齡等資料時，還可以針對不同時間點，在三維數碼環境中顯示未來不同年份的大廈年齡群，模擬市區老化情況，這些技術對規劃工作都非常有幫助。

然而萬丈高樓從地起，要令這個先進的市區更新資訊系統成功發揮作用，Edmond說還得先做好最根本的數據管理工作；重中之重，是要為系統建立一

In addition, the 3D UR Planner, which is another application tool under the URIS, enables planners and architects to conduct 3D analysis. For instance, in an environment of old buildings, how would a redevelopment project affect the daylight condition of its surrounding buildings? Does a designated unit in the redevelopment projects have an open view? To find out the answers, planners and architects can make use of this 3D planning tool to create viewsheds at different units for analysis. In addition, when integrated with buildings age data, the 3D UR Planner can simulate different scenarios of urban decay at multiple points of time, thereby helping the planning work of the URA to a great extent.

Nevertheless, as the old saying goes that lofty towers are built from the ground up, data quality and its management is essential to building an effective URIS, of which the construction of a Core Data Model (CDM) is part and parcel to the endeavour. The CDM will consolidate, define and standardize data that is currently being collected and stored by different departments of the URA. Upon the building of CDM, staff from different departments can easily retrieve the well-defined and standardized data from the same source, thereby eliminating the possibility of using inconsistent data between departments and hence ensuring data accuracy.
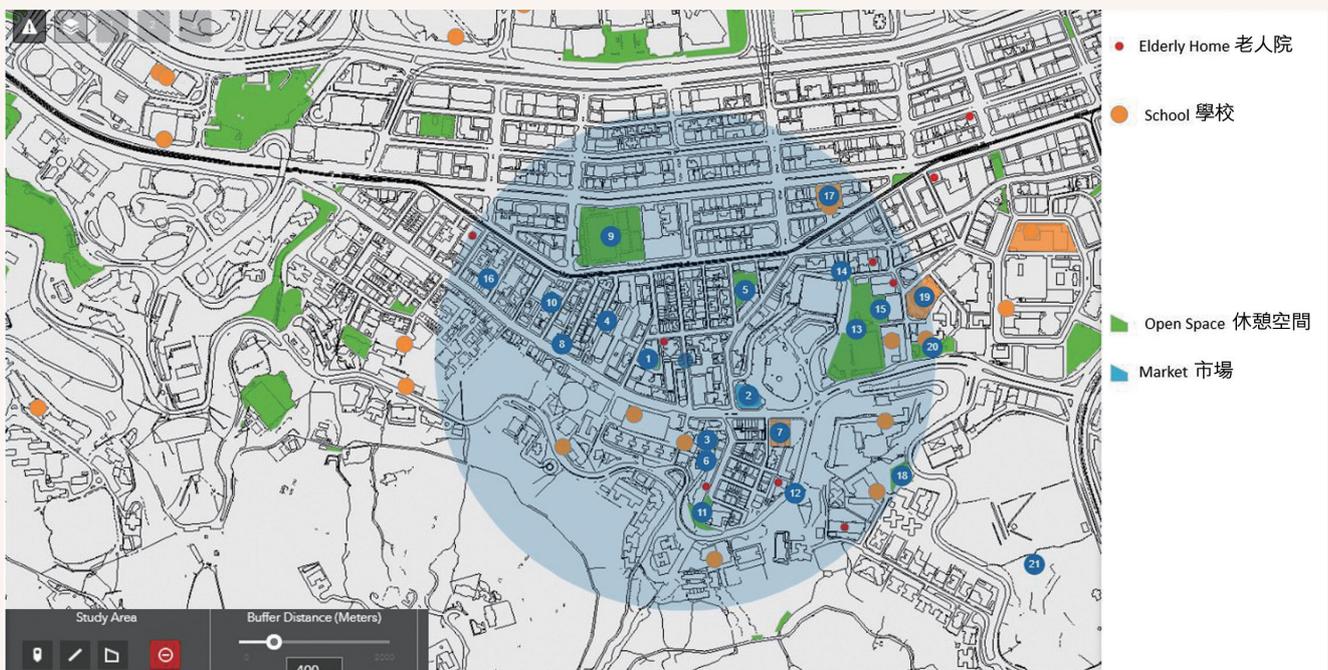
在市區更新資訊系統下，不同種類及來源的規劃資料可在平面地圖上輕易整合和分析，一目了然；如圖中的老人院、學校、市場和休憩空間等資料便以不同顏色同時顯示。
The URIS can help integrate different planning data in 2D map for analysis with ease, as shown on the map where information related to elderly centres, schools, markets and open spaces are indicated by different colour markers.

個中央數據庫（Core Data Model），讓本來存於不同部門的市區更新數據，以統一的標準格式（Data standardisation）來整合和儲存，方便檢索；日後各部門人員既摘取來自同一數據庫的資料，便可避免不同部門的研究或方案出現參考數據不脗合或需耗時驗證的情況，有助提高工作效率及準確度。

從長遠的角度看，市建局建立URIS亦是為日後能連繫由政府設立的空間數據共享平台（Common Spatial Data Infrastructure）而鋪路，以及積極回應政府的開放數據政策（Open Data Policy）。Edmond說，日後待數碼基建成熟後，不同政府部門和公共機構便能透過地圖應用程式界面（Map API），即時摘取由各部門提供並符合開放標準和機讀格式的數據，「情形就好像當電插頭連接到插座便能通電一樣，到時只要利用Map API，其他部門的數據便可即時傳送至市建局的資訊系統！同時間市建局的數據，如已重建項目的部分資料等，亦可透過Map API 與其他部門和市民共享。如此一來，我們毋須再花時間逐一向不同部門索取資料光碟，然後再逐項輸入系統。」Edmond說。這個旨在支援各種智慧城市應用發展而設立的空間數據共享平台，政府早前表示初步會開放給旗下部門和公共機構互通互用，稍後亦會開放部分數據予公眾。

「市區更新資訊系統」（URIS）的建立，讓市建局能掌握更多、更全面，以至更即時及可與政府部門互通互用的數據，有助市建局以數據為本，制定更創新的市區更新策略。
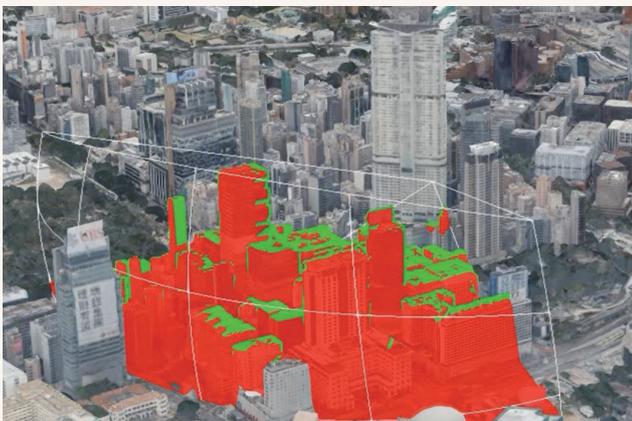
3D UR Planner可模擬單位視域，進行三維空間研究。圖中的綠色部分代表在特定大廈單位內，可望到的景觀範圍。
3D UR Planner enables planners and architects to conduct 3D viewshed analysis of a designated unit. The visible area from the given location is indicated in green.
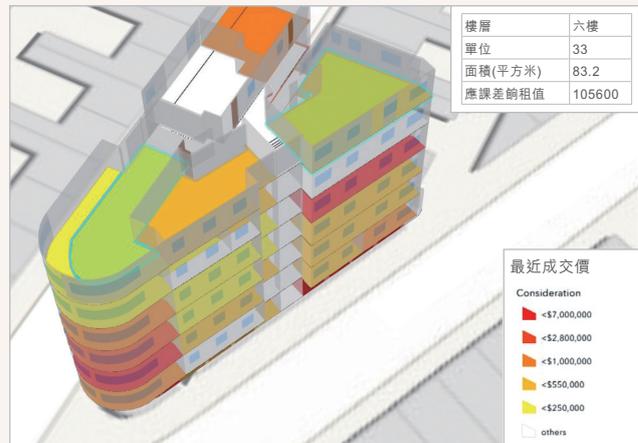
未來的3D iMap可包含不同空間數據，如大廈建築資料、單位租值數據等，方便計算維修工程預算費用及審批業主的資助申請。(圖片由「ESRI 香港及加拿大」協助提供)
The '3D iMap', conveying different types of business data such as buildings information and property valuation, can help generate building rehabilitation works estimates and facilitate the vetting of owners' applications for subsidy in the future. (Courtesy of ESRI HK & Canada)

On a long-term perspective, the development of URIS is also an URA's initiative to pave the way for interfacing with the Government's Common Spatial Data Infrastructure, as well as to proactively respond to the Open Data Policy advocated by the government. Edmond envisaged that when the technical infrastructure becomes mature, different government departments and public organisations could access up-to-date data in an agreed open standard and machine-readable format from their counterparts via a Map Application Program Interface ('Map API'). "By then, with the adoption of 'Map API', data from other departments will be transmitted instantly to the URIS, just like how electricity is distributed once you put the plug in the socket! Simultaneously, data of the URA, such as part of the information on our completed redevelopment projects, could be shared with other government departments or even the public via 'Map API'. As a result, we don't have to spend time requesting data from individual departments and then manually processing their data which are normally stored in CD-ROMs," said Edmond. The Common Spatial Data Infrastructure that aims to support various types of smart city applications development will first be made inter-operable among government departments and public organisations, and at a later stage, open to the public with limited data access.

All in all, the establishment of the URIS allows the URA to get hold of more comprehensive and up-to-date information through the interchanges of data with government departments, thereby facilitating the URA in the formulation of more data-driven and innovative strategies on urban regeneration.

電腦模擬協助分析環境數據
創造更宜居環境
Creating Liveable Environment by Analysing Environmental Data with Computer Simulation

Rebecca（右）說，電腦模擬數據協助分析設計方案對環境的影響，有助團隊與顧問反覆研究出更好的方案。

Rebecca (right on photo) said with computer-simulated imagery, the URA is able to get hold of various environmental data and analyses of the design model's impact on the community environment, which help strengthen its capacity to deliberate with consultants for better design options.

為創造可持續和宜居的生活環境，市建局在擬定市區更新方案的過程中，需要考量項目及周邊地區的地理和環境氣候數據。為加強市建局在數據處理和分析方面的能力，團隊近年積極借助創新科技，利用應用軟件建立數碼虛擬模型，通過模擬技術來評估設計方案在環境及可持續性方面的可行性。

市建局的規劃及設計團隊去年與香港大學建築學院「HKUrban Lab」合作，共同研究利用不同的應用程式，就城市風向氣流、戶外體感舒適度和日照比率等環境數據進行分析，了解不同設計對周邊環境的影響，以及探討令項目及鄰近環境更舒適和宜居的方案。同時，市建局團隊及「HKUrban Lab」亦在位於九龍城區的重建項目中，運用了這些電腦模擬工具以作試驗研究。團隊成員之一的規劃及設計項目統籌李百嘉（Rebecca）說，這次經驗可謂獲益良多。

事實上，小區重建規劃不只講求環境美觀，更注重宜居。例如在炎炎夏日，香港市區溫度經常高達攝氏三十度或以上，如何透過規劃設計讓城市環境降溫便成為一大題目。Rebecca說：「其實主要看空氣流通。根據城市設計指引，規劃布局中必須設有通

To create a sustainable and liveable environment for people living in the redevelopment project area and its vicinity, URA studies the geographical and environmental data of the area during the process of formulating the respective urban renewal proposals. And to enhance the capability of the URA in data processing and analyses, the team has, in recent years, actively adopted innovative technology and employed application software to build digital virtual models and to generate simulated results for assessing micro-climate impacts and the sustainability of design proposals.

Last year, the URA's planning and design team has collaborated with 'HKUrban Lab' of The University of Hong Kong's Faculty of Architecture to jointly study the environmental conditions such as urban wind flow, outdoor thermal comfort and daylight, particularly at the pilot study area of Kowloon City. Multiple data were analysed using various application software to look into the environmental impact of different designs in the project vicinity, with a view to explore better design for improving comfortability and liveability within the neighbourhood. Simultaneously, computer simulation tools were also applied in the pilot study of the Kowloon City district-based redevelopment projects. Rebecca Li, Project Coordinator of the Planning and Design Department at URA, and also a member of the research team, considered the experience very rewarding and valuable.

風廊來促進空氣流通，幫助散熱，改善環境中的微氣候。」誠然，同業在擬定設計方案時都會滿足這些條件，但實際效果往往有賴專業的環境顧問進行空氣流通評估（Air Ventilation Assessment），在實體的風洞 （Wind Tunnel）或透過計算流體動力學(Computational Fluid Dynamic) 的模擬方法，就設計模型進行各種測試，並讀取和分析數據，才能驗證效果。問題是，進行這樣的專業評估往往需時以月計，若想即時改良設計方案再測試效果更是費時。

相比之下，透過應用軟件「AKL FlowDesigner」來模擬設計方案本體及周邊環境，便可以電腦技術快速評估風向氣流，「即使是十公頃範圍以內的數據，只需運算半小時便完成！」Rebecca說。電腦模擬結果又可以預視個別位置的問題，例如街道上的湍流等。「有時通風廊收窄，的確會增加風速，讓空氣帶到更遠，不過街道環境複雜，亦要小心出現湍流的可能性，否則遇極端天氣如颱風時，便容易出現爆玻璃情況。總的來說，如果風速或舒適熱度過高，我們可以考慮更改部分設計，改善社區的微氣候，提高周邊環境的戶外舒適，為社區環境帶來長遠裨益。」此外，港大與哈佛大學在過去幾年合作研發出能評估戶外體感舒適度的軟件「CityComfort+」，能結合風向氣流的數據，綜合評估人體對光度、溫度、濕度和風速的感知以及太陽輻射、建築物料的熱容量和放射率，幫助市建局團隊了解所設計的社區環境之體感溫度是否舒適，這項評估亦是其他項目發展機構少有的。
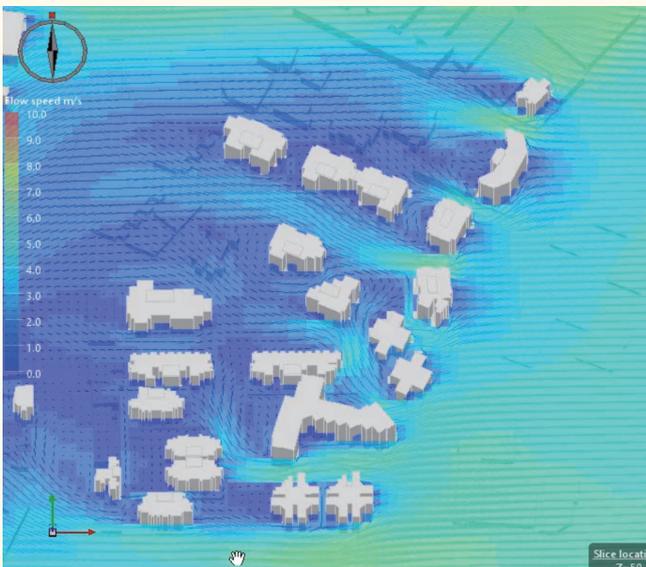
District-based planning emphasises not only on the aesthetic design of environment, but also on liveability. For instance, how to improve thermal comfort in the city environment by means of planning and design has always been a major topic as urban temperatures in Hong Kong often exceed 30°C during summer. Rebecca said, "Airflow is always one of our major concerns. According to the Urban Design Guidelines of Hong Kong, breezeways are to be considered in the layout plan to facilitate air circulation and heat dissipation, thus improving the micro-climate of the environment." And when formulating plans, it is often that the design teams may have to rely on results and analyses generated by professional environmental consultant via Air Ventilation Assessments(AVA), during which different design models would be tested through physical wind tunnel model or computational fluid dynamics (CFD) simulations. Yet the whole process may take months to complete, not to mention that longer time would be required for retesting the improved design options.

However, with the 'AKL FlowDesigner' software, quicker wind simulation results can be generated. "It would only take half an hour to generate simulation results for an area of ten hectares!" said Rebecca. Computer simulation would also be able to pick up specific problems such as turbulence on streets. "Narrower path could increase wind speed allowing air to travel further to the inland of site. However, we shall also be aware of the possibility of turbulence due to the complex street environment at pedestrian level, for instance, during extreme weather conditions like typhoon, windows could be smashed under high wind. To sum up, in cases of excessive wind flow or thermal discomfort, we would consider refining the design to improve the micro-climate of the community, as well as to reduce thermal discomfort in the neighbourhood, thereby bringing long-term benefits to the community environment," she explained. Furthermore, the 'CityComfort+' software jointly developed by The University of Hong Kong and Harvard University was also employed in the study to help the team understand the outdoor thermal comfort level of the community environment by taking into account the human perception of day-lighting, temperature, humidity, wind speed, solar radiation, as well as heat capacity and emissivity of building materials etc. altogether. This kind of thermal comfort assessment is rarely being adopted in other development projects in Hong Kong.

團隊透過應用軟件，快速評估設計方案本體與周邊環境的風向氣流，並由藍至紅色來顯示最低至最高的風速。
With 'AKL FlowDesigner' software, wind simulation results can be generated quickly, as shown by the colour legend denoting different wind speed values.
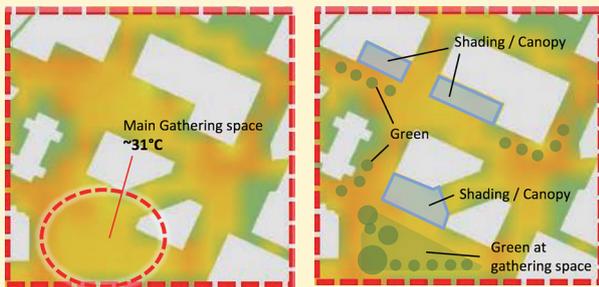
在戶外地方加設遮陽設計，如上蓋或樹蔭等，可帶來降溫效果。左圖為加設遮陽設計前錄得較高的通用熱氣候指數的情況；右圖中綠色部分顯示當加設遮陽設計後，相關指數下降，代表戶外舒適度有所改善。
In open spaces, shading devices, such as shelters or tree canopies, can bring improvement to thermal comfort. Photos on the left shows the scenario with relatively high universal thermal climate index (UTCI), whereas in photo on the right, after installing shading devices, there are improvements in the outdoor thermal comfort level as indicated by a lower UTCI index.

雖然用作評估環境數據的應用軟件愈見先進，但Rebecca補充，其所模擬出來的分析結果並不能替代專業的空氣流通評估，「始終研究風向氣流的流體動力學（Fluid Dynamics）是個專業領域，需要非常精準的測試、研究和分析才能得出符合標準的報告。」不過她說，電腦模擬以圖像來分析及顯示不同設計規劃方案對社區環境的影響，亦可讓市建局掌握更多客觀環境評估數據和分析，有助團隊與顧問反覆研究出更好的設計方案。

此外，是次合作研究亦利用「AKL FlowDesigner」、「CityComfort+」，以及用以分析日照比率的「Diva For Rhino」等三套應用軟件，綜合不同環境評估數據和分析，從而制定出一系列包括風速、體感舒適熱度、日照比率和眩光等符合香港城市環境的宜居性指標，以及提出一些可改善環境舒適性的初步建議，以供日後項目發展參考，務求能在小區發展模式下制定更為居民所悅的優質社區，為香港實現可持續發展的願景。

Despite the technological advancement of these environmental assessment software, Rebecca added that professional and conventional assessments of air ventilation are still irreplaceable, "The fluid dynamics is a professional discipline, and the study of wind flow requires the conducting of sophisticated tests, researches and accurate analyses in order to meet professional standards for government approval." Nevertheless, with the help of computer-simulated imagery, the URA is able to get hold of various environmental data, as well as analyses of the design model's impact on the community environment, which help strengthen its capacity to constantly deliberate with consultants for better design options.

In addition, with the help of 'AKL FlowDesigner', 'CityComfort+' and 'Diva For Rhino' software, the study has also set out a series of benchmarks for acceptable micro-climate conditions for Hong Kong. Upon integration of different environmental assessment data and analyses, these indicators of a city environment's liveability encompassing wind speed, thermal comfort level, daylight factor, glare and others, will give important reference for the planning and design of URA's future redevelopment projects, alongside recommendations of better design for improving the district's comfortability. As such, the URA would be able to achieve better quality of communities for residents under the district-based approach.

Research Suggestion

Under certain circumstances, shading devices, such as shelters or tree canopies, can bring improvement to thermal comfort. Other more active devices could also be adopted in areas where design alone cannot make any improvements. In view of this, the URA team will continue to study the feasibility of introducing innovative shading devices, including mist cooling and solar umbrella and their effect on the surrounding environment.

研究建議

在某些情況下，遮陽設計如加設上蓋或樹蔭等可帶來降溫效果，但假若效果不太顯著時，則可考慮引入更進取的裝置或設計。有見及此，市建局團隊將續研引入其他嶄新遮陽裝置的可行性，包括利用降溫噴霧（Mist Cooling）或太陽能傘篷（Solar Umbrella）等，探討其對周邊環境可帶來的影響。

降溫噴霧 (圖片由Dana McMahan提供)
Mist cooling (Courtesy of Dana McMahan)

「BIM建築信息模型」技術
保育中環街市的智慧工程管家

Building Information Modelling (BIM) -
Preserving the Central Market with Smart Work Management Tools

當市建局團隊最初接手為中環街市進行保育及活化工程時，可沒有想過馬上便遇到第一重挑戰：向不同政府部門「翻箱倒篋」地索取建築圖則，卻因年代久遠致散失而遍尋不獲。但既要開展復修工作，則必須先為整幢中環街市「度身」繪畫圖則；其時，被視為業界前沿科技的「建築信息模型」（Building Information Modelling，簡稱BIM）技術正好派上用場。

The URA's Central Market preservation project team faced an unexpected first challenge soon after they took over the work, when repeated effort spent in the search of the market's building plans with various government departments had become futile and all existing building plans were reported missing during the long years. At the time when the team was in dire need of an accurate set of architectural drawings for design, the cutting-edge technology of Building Information Modelling (BIM) came in handy to help redraw the plans.
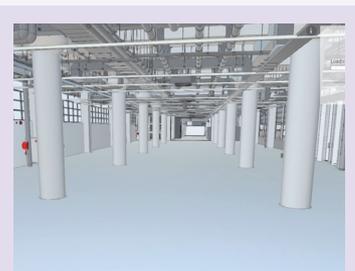
Christine説透過BIM將建築資訊視像化，現在只要拿著平板電腦便能在現實場地準確檢視建築細節。細圖為同一空間的BIM三維圖像。

As all building information can be visualised through BIM, Christine can now inspect construction details on-site with her tablet. Alongside is the three-dimensional BIM image of the same location.

「建築信息模型」（BIM）是指在建築設計、施工及整個建築生命周期中提供有關產生和管理建築數據的技術過程，當中包括設立一個涵蓋建築、結構及土木工程、園境、機電及管道、屋宇設備、空間關係、地域性資訊、建築物元件數量及特性等資料的建築信息數據庫，再透過「三維」（3D）建築模型軟件，便可將收集得來的數據整合並以不同的視像方式呈現，例如三維立體視像、平面圖、立面、橫切面或透視圖等等。配合各種與BIM相關的應用軟件，亦可用於自動運算各類準確的建築及環境資料，如計算流體力學、自然採光的照明效果及空調能源效益等，甚至可根據建築構件資料及數量自動計算出工程的預算費用。

BIM refers to the technical process involving the generation and management of building-related information during its stages of design, construction and throughout the entire building life cycle. It includes the setting up of a BIM database that encompasses information on construction, structural and civil engineering, landscaping, mechanical, electrical and plumbing works (MEP), building facilities, spatial relation, geographic information, building components and others. With the help of 3D building modelling software, the data gathered is then integrated and visualised in various forms including three dimensional images, floor plans as well as elevation, cross-section or perspective plans. When used in conjunction with different BIM software, users can easily generate data and analysis on buildings and the environment, such as those on fluid dynamics, daylighting and energy efficiency of air

中環街市（圖左）的圖則遍尋不獲後，團隊在前期設計階段決定利用鐳射掃描和點雲方式，協助製作精密的BIM模型（圖右）。
After all existing building plans of the Central Market (photo on left) were reported missing, the team decided to adopt laser scanning and point cloud technology to help create the comprehensive BIM model (photo on right) .

有份參與中環街市保育項目的市建局規劃及設計經理葉慧媚（Christine）說，為重繪中環街市的圖則，團隊在前期設計階段便為建築物「度身」，利用鐳射掃描（Laser scanning）技術，將中環街市的內外範圍的細節以點雲方式（Point cloud）記錄下來。由於每一點均包含三維座標，因而可取得一個與實物相同的立體模型，其精確度十分之高；團隊其後以此點雲模型（Point cloud model）作基礎，轉化為更精密的BIM模型，以作進一步測量和繪製設計圖則之用。

Christine認為，BIM在建築及設計過程中最重要的作用，可說是它的高度視像化 (Visualisation)特性，讓負責不同範疇的人員在設計階段可以聚合在一起討論和互相協調細節，並以三維視像模型作碰撞分析（Clash analysis），預視各設計範疇會遇到的位置碰撞問題，合力找出解決辦法去「砌好個模型」。她說：「在項目裡分別負責建築、機電及管道設備，以及結構的工程顧問，現在不再各自埋頭苦幹，而是經常一齊開會，利用BIM將不同範疇的設計細節整合起來，再逐一檢視三維模擬影像，要是發現有問題便立即集體想辦法解決；比起在傳統做法下，往往要待至施工時才發現問題及修正，這樣無疑更能節省時間及成本。」

BIM這種創新技術，對於應用在中環街市這一類保育項目上，還有更深一層意義。Christine解釋，在保育及活化工作上，團隊既要想辦法使歷史建築符合現

conditioning systems. In addition, quantity surveyors can easily derive cost estimates from the detailed information of building components and their quantities from the BIM database.

Christine Yip, Planning and Design Manager of the URA and a member of the Central Market preservation project team, said they have adopted laser scanning in the early design stage for capturing both the internal and external dimensions of the existing structure to create a point cloud model based on a collection of points at their 3D coordinates. A more comprehensive BIM model, which was formed based on the point cloud model, was then used for further measurements and generating design drawings.

Christine said during the design and construction stages, she was most impressed by the high visualisation quality of BIM that allows members of the design team who are responsible for different aspects of a project, to discuss and coordinate the project details. With BIM software, clash analysis can also be conducted to detect potential collision of elements in the design model, so that team members can work out solutions together. "Design consultants from different disciplines like architectural, structural and MEP are no longer working on their own, but are gathering frequently to integrate their design content into one BIM model. As soon as we visualise the clashes in the 3D imagery, we are able to fix them together at early design stage. Comparing with conventional practices in which problems are usually discovered on the site, this is undoubtedly more time-saving and cost-efficient," she said.

For projects involving the preservation of historical buildings like the Central Market, BIM also serves another meaningful

Trunking **A/C Unit**
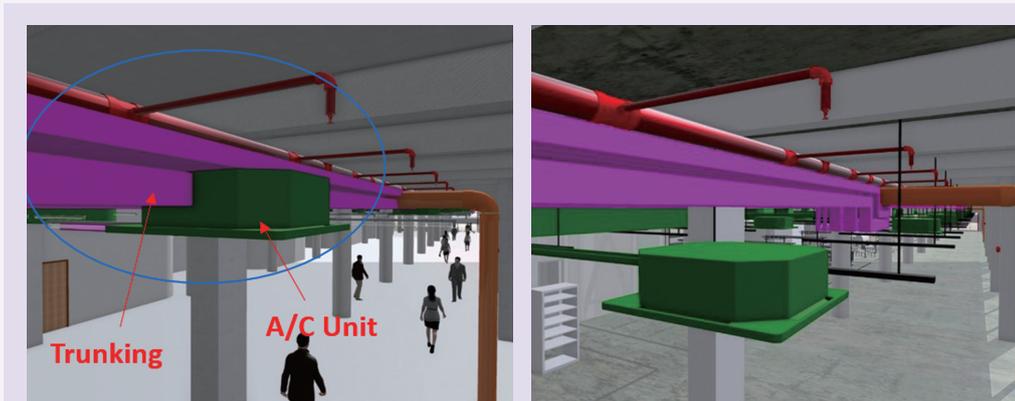
團隊可利用BIM軟件作碰撞分析，預視各設計範疇會遇到的位置碰撞問題。如左圖中以綠色顯示的空調設備，正好陷入了以紅色標示的管槽位置。右圖是解決碰撞問題後的改良設計。
With BIM software, clash analysis can be conducted to detect potential collision of elements in the design model. In the photo on the left, the air-conditioning unit (as shown in green) is colliding with the trunking (as shown in red). The photo on the right shows the rearrangement of the air-conditioning unit's position for solving the problem.

function. According to Christine, during the course of preservation and revitalisation, the team has strived to upgrade the building facilities in order to meet modern standards, while on the other hand, adopt a minimum intervention approach to conserve the Central Market without affecting its existing structure or façade and be meticulous not to cause any damage to the original environment.

代屋宇設備標準，但同時又要盡量避免過度侵入原來的結構或立面，或破壞原來環境，因此在細節上更要留神。

例如中環街市內那條標誌性樓梯，除了是已故攝影大師何藩經常流連的地方外，亦曾多次出現在他的作品中，十分具歷史文化價值。項目團隊為提升中環街市設備標準，原本打算在樓梯上的天花板位置鋪設冷氣槽和照明燈光，但經BIM三維模型視像一看，很快便決定要更改設計。「那個是『打卡位』（攝影位置），天花板上太多的機電設施會令樓底變矮，影響觀感。我們一直想盡量保存攝影作品中那個背景樓梯的風格和美感，因此最後決定移走部

The preservation of the iconic grand staircase inside the Central Market provides a perfect illustration of the benefits brought by BIM application. Captured in a number of prominent works by the late renowned photographer Fan Ho, the grand staircase at Central Market has become a treasure of significant historical and cultural values over the years. As part of the initiative to upgrade the Central Market's facilities, the project team initially planned to install air conditioning ducts and lighting on the ceiling above it, but the team soon decided to go for some rearrangement after inspecting the BIM model. "The grand staircase, being a photography spot, should not be occupied by too many MEP facilities that would limit the ceiling height becoming an eyesore in any typical photo capture. We hope to preserve the ambiance and aesthetic view of the grand staircase as portrayed many years ago in the works of Mr Ho. As

BIM的高度視像化特性，讓不同範疇的人員在設計階段可以聚合在一起討論和互相協調細節。
The high visualisation quality of BIM allows members of the design team who are responsible for different aspects of a project, to discuss and coordinate project details together.

分喉管，騰空樓梯頂部的空間，保留了樓梯的整體氣氛，盡量在保育與提升現代屋宇設備之間取得平衡。」Christine說。

除「三維」（3D）立體模型外，團隊於中環街市不同的設計及工程階段亦採用了其他BIM技術，例如加入「四維」（4D）營建模型技術來模擬施工計劃，預視實際施工時的程序和狀況；這樣工程人員便能更好地籌劃施工安排，除減少在施工現場出現問題的可能性，亦可以此對比和監察實際工程進度，做好時間管理及提高工程效率。此外，工料測量師亦引入「五維」（5D）成本管理技術，利用BIM資料庫內的建築工料數據，更準確地計算工程合約估價，以及分析實際工程量數據及按進度支付工程款項，大大加強項目管理的效率。

a result some services were moved apart from it, sparing ample space at the ceiling above the staircase. During the process we have tried to strike a balance between preserving a heritage and maintaining modern building standards," said Christine.

In addition to 3D models, the team has also adopted other BIM applications during the design and construction stages of the Central Market, for example, the fourth dimension of advanced works simulation for previewing important construction sequences and planning of the work progress so that work efficiency can be enhanced and progress can be monitored to lessen the need for site coordination during the construction stage. Moreover, for cost management sake, quantity surveyors have also made use of the fifth dimension on the generation of quantities of completed work from the BIM progress model, which tracks the work progress and provides more accurate reports of the contractual sum for subsequent settlement of contractors' interim payment.

已故攝影大師何藩愛流連中環街市，並經常於地下的標誌性樓梯取景，令該處極具歷史文化價值。團隊在檢視該處的BIM三維模型影像時看到太多機電設施，於是決定移走部分喉管，騰空樓梯頂部的空間，保留了樓梯的整體氣氛。（何藩，Afternoon Chat ，香港，1959，圖片由Blue Lotus Gallery提供。網址: www.bluelotus-gallery.com及https://fanho-forgetmenot.com）

Captured in a number of prominent works by the late renowned photographer Fan Ho, the grand staircase at Central Market has become a treasure of significant historical and cultural values. After inspecting the BIM model, the team decided to move away some services sparing ample space at the ceiling above the grand staircase, in order to preserve its ambiance and aesthetic view. *(Fan Ho, 'Afternoon Chat'. Hong Kong, 1959, courtesy of Blue Lotus Gallery at www.bluelotus-gallery.com and https://fanho-forgetmenot.com)*

其他「建築信息模型」（BIM）的創新用途
Innovative Applications of BIM Beyond Construction Modelling

正因為「建築信息模型」（BIM）擁有龐大的數據整合和管理能力，它除了在設計及營造過程中發揮巨大作用外，還在建築物的生命周期中有很多創新的應用可能；在某些領域上，它甚至逐漸改變了行業的作業模式。

Given its huge data integration and management capacity, BIM has brought along a series of innovative applications throughout the building life cycle apart from playing a significant role during the design and construction stages. In some cases, the technology has even instilled changes in some industries' modus operandi.

「BIM設施管理系統」

項目在設計及建造期間利用BIM整合和建立了全面的建築數據庫後，這些重要資料不會隨着項目落成而被丟棄，反而可以幫助提高設施管理的效率。「BIM設施管理系統」的基礎，就是將BIM建築數據庫內鉅細無遺的建築物元件和設備等數據，續用到設施管理系統上。管理人員只需在電腦平台上透過三維模型視像顯示，便可實時監測建築物內不同系統及設施的狀態，以至控制它們的開關；假如發生問題，系統還能即時自動發出維修通知，遣派工程人員到顯示有問題的位置檢查。此外，「BIM設施管理系統」亦會因應設施的周期和狀態，定時提醒工程人員作測試和檢查，避免設施損壞後才作補救。

BIM Facility Management System

The BIM databases, which are built during the design and construction stages, are most instrumental in enhancing facility management efficiency. The BIM Facility Management System (BIM-FM), integrating every big and small building components and facilities data from the BIM database, enables real-time monitoring as well as remote control of the building systems and facilities through three-dimensional visualisation of facilities and their locations on a computer platform. Moreover, the system can automatically issue works orders to maintenance engineers whenever problems are detected, and schedule reminders to alert maintenance work staff to conduct inspections, so that preventive measures could be implemented to avoid any damage.
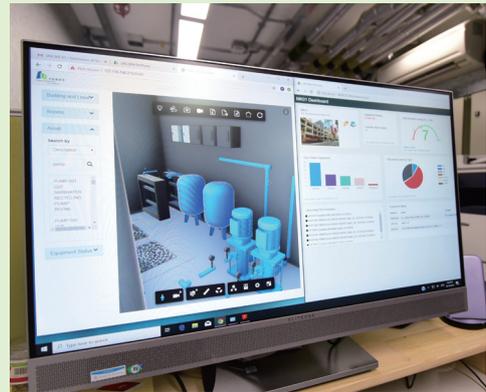
管理人員透過「BIM設施管理系統」的三維模型，便可在電腦平台實時監測建築物內不同系統及設施的狀態，或控制開關。
The BIM-FM system enables real-time monitoring and remote control of the building systems and facilities through three-dimensional visualisation of facilities and their locations on a computer platform.

至截稿前，市建局位於上海街的保育及活化項目工程即將完成。這個項目在設計及建築階段便已引入BIM技術，而隨着項目投入營運，亦已發展出一套「BIM設施管理系統」。系統內載有詳細數據，包括項目中歷史建築部分的建築物料和復修記錄等，方便日後管理及維修之用。此外，「BIM設施管理系統」又與物聯網（Internet of Things）技術整合，讓升降機和消防門等裝置的開關或運作狀況，可以實時傳送至系統；團隊並正研究透過感應器，實時監測洗手間空氣質素的技術，使設施管理更智慧和自動化。團隊憑着創新理念，將BIM技術融合在整個保育活化項目內，不但於早前取得Autodesk Hong Kong BIM Awards獎項，更在今年十月再度榮獲國際性大獎2019 AEC Excellence Awards。

BIM自動計算實用面積

在策劃和設計的過程中，項目團隊往往要耗費大量時間，以人手計算不同設計方案的實用面積（Saleable Area），在忙亂中亦有機會出錯誤。為提高準確性又符合經濟效益，市建局團隊正設定運算程式，以BIM所儲存的項目建築數據作為基礎，利用BIM外掛程式，快捷準確地自動計算出每個單位的實用面積；同時只需簡單步驟，便能對不同設計選項的面積進行分析，即時評估實用比率和財務收益，增強工作效率。

活用BIM協助樓宇復修

市建局去年曾以試驗計劃性質，引入BIM技術協助舊樓進行樓宇復修。工作人員利用掃描技術，在大廈不同位置進行全方位的實景掃描以獲取樓宇外牆數據，再透過三維模型軟件將數據繪製成立體圖像，結果不但為業主提供了準確的工程範圍數據和圖像參考，還以這些資料協助工程顧問籌備更詳細的招標文件招聘承辦商，使承建商的回標價更貼近實際工程要求。
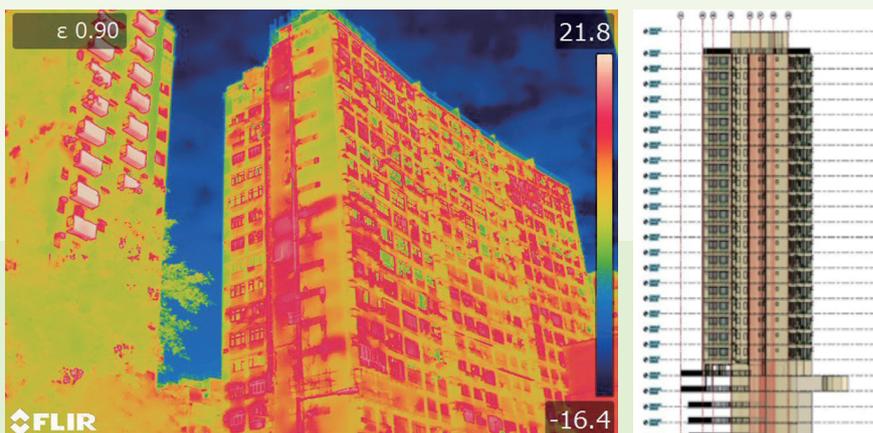
The application of BIM technology in the design and construction of the URA's preservation and revitalisation project at Shanghai Street has earned it the Autodesk Hong Kong BIM Awards, as well as the latest global recognition of the Autodesk's 2019 AEC Excellence Awards. The BIM-FM system, built upon the BIM construction model comprising of building components data and rehabilitation records of the historical building, makes facilities management and repair easier as it commences operation. Moreover, the integration of BIM-FM system and Internet of Things (IoT) technology also enables the real-time monitoring of facilities' operation including elevators, fire-rated doors and air quality in toilets.

Automated Calculation of Saleable Area

During the planning and design process, project teams often have to spend significant time in manual calculation of the saleable area of design options, during which arithmetic errors may occur. To ensure accuracy and maximise benefits, the URA has devised computer algorithms as a plug-in function to automatically generate the saleable areas of residential units with BIM software with precision leveraging the construction data in the BIM models, alongside analyses on the efficiency ratio and financial benefits of different design options.

BIM to Assist in Building Rehabilitation

The URA experimented the application of BIM in building rehabilitation last year, in which laser scanning at different perspectives was employed to capture data of the building's exterior for building its 3D BIM model. The initiative not only provided accurate building works data and images for owners' and contractors' references, but had also facilitated the preparation of more comprehensive tender documents resulting in more competitive tender proposals and prices.

團隊在樓宇外牆實景掃描，再透過三維模型軟件製成立體圖像。
Laser scanning was employed to capture data of the building's exterior for building its 3D BIM model.