

第六章 結論

本研究最關切的焦點問題：如何透過空間認知的理論掌握空間知識的結構，並藉由認知圖與城市空間意象的視覺圖像研究，來建立實體與數位空間所存在的認知因子關係，以轉換網際環境的場所認知，並建立數位城市的空間認知理論模型。所以，首先透過空間認知的文獻分析推論，修改KWAN的理論模型，提出一個初期的認知關係模型，作為數位城市的視覺圖像分析依據。此一關係模型是基於假設在虛擬環境中亦有一與實體空間相同的認知關係。其次，為了深化此一初期模型的空間性因子，提出一個空間性的認知實驗。在認知實驗設計上以不同的媒材呈現，來驗證空間感的認知是來自實體環境的認知圖繪關係，不受不同專業訓練的影響。而從實驗中找出基於實體空間的空間感因子的排序，以及驗證媒材的不同會有不同的空間感因子排序，這是基於不同專業的訓練。最後，將修正的模型用來分析線上的數位城市以得到驗證，並找出圖形界面設計的重要空間性因子。

6.1 總結

本研究所提出的理論模型是透過空間知識結構的建立，以認知圖理論與瀏覽的認知經驗研究，在知覺、視覺、聽覺以及瀏覽經驗上，尋求解決『實體與網際虛擬環境在空間性認知的差異』，來減低數位城市在視覺性界面的『迷失方向』與『認知負荷』。因此，在網際空間性認知研究的理論架構下，所提出的認知模型，有以下三類特徵（如圖 6-1）：

1. 藉由網際空間的地圖性，把數位城市想成是大尺度的地景環境，而其空間知識就像人類的認知圖結構。
2. 透過Lynch的心智圖對都市環境的觀點，將網際空間的認知研究所強調的定位、探路或瀏覽輔助以及地圖，轉換成數位城市的空間認知焦點。
3. 透過記憶的研究，將網際的空間認知過程分成資訊地景、感知界面與記憶三大循環流程。當我們感知世界時，外部環境的輸入會刺激感知覺察的記憶，並分解成言語及視覺元素傳送到工作記憶區，然後從這些元素篩選並儲存到長期記憶，最終形成空間知識的認知圖。

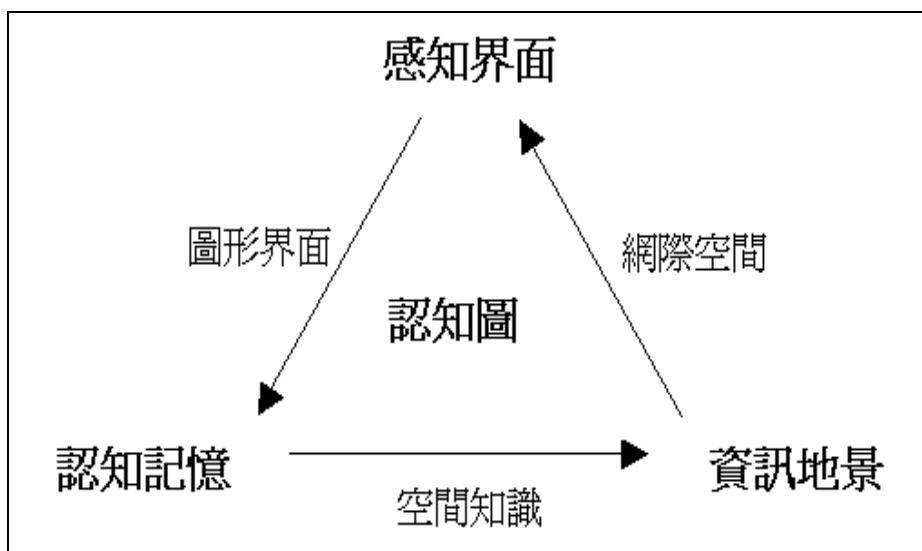


圖 6-1：理論模型的架構。

而整體的研究結果，可用數位城市的空間認知、超媒體空間（圖形界面）的設計操作以及瀏覽探路的經驗轉換等三個面向來詳加說明。

6.1.1 數位城市的空間認知

由於實體城市的既有空間理論在分析數位城市時有不足之處；因此，本研究透過認知理論、城市意象、認知圖與超媒體空間的特徵，來探討數位城市的空間認知。人類在實體環境中基於瀏覽探路的空間經驗，會形成具有階層性的空間知識，從路標到俯視知識的階層結構。而在網際環境中，透過第三章文獻分析研究以及第四章的認知實驗，知道人類的實體空間知識會轉移到網際環境中；但由於觀看『螢幕』的視野限制及缺乏身體直接的空間感受，在空間知識上為了避免迷失方向，最重要的是俯視知識的地圖提供以及身體的位置資訊。路標知識在網際環境中，反而是作為數位城市特定的瀏覽任務，如提供場所感知及連外資訊。因此，研究發現網際環境的空間知識有別於實體環境，並可從空間知識的組織與空間組成元素來看。

一、數位城市的空間知識組織

1. 數位城市的空間知識組織有位置資訊、路標知識及俯視知識。位置資訊的知識組織有化身符號、身體圍繞及視點轉變。路標知識的組織有地標、路徑或通道以及節點。俯視知識的組織有區域、邊界以及地圖。
2. 在認知記憶上，位置資訊過濾視覺與聽覺屬工作記憶區，路標知識過濾事件屬長期記憶區，俯視知識提供地圖屬長期記憶區的認知圖。
3. 數位城市的空間知識首重俯視知識的提供以及位置資訊的確認，因為在階層性

的結構閱讀上，具有非線性與跳躍式的分離連結特性，與實體城市不同。

二、數位城市的空間組成元素

1. 數位城市的空間元素分成三類：自我座標、感知特徵以及空間架構。
2. 位置資訊是作為模擬實體環境中身體的空間知覺，以提供圖形界面的自我座標，其空間性因子有位置移動、視景轉變以及立體物件。
3. 路標知識是作為模擬實體環境中場所的空間知覺，以提供圖形界面的感知特徵，其空間性因子有立體物件、透視、層次、光影、背景音樂、動態影片、視景轉變以及位置移動。
4. 俯視知識是作為模擬實體環境中空間的認知圖，以提供圖形界面的空間架構，其空間性因子有立體物件、透視、層次、視景轉變以及位置移動。

6.1.2 超媒體空間的圖形界面設計

在網際環境中，數位城市是透過圖形界面來呈現，而呈現的界面是受到網路媒材的科技與使用工具的技術影響。在研究中顯示，數位城市的視覺性圖形界面，除了要轉化空間知識外，為了不迷失方向及有效減低認知負荷，還需要考慮自我座標、感知特徵與空間架構的視覺媒材提供以及空間瀏覽的輔助；所以，在網際環境中數位城市的圖形界面會有分割。在第四章的媒材認知實驗中指出，虛擬實境（3DVR）的視覺呈現在空間感與場所感的表現上，會有身在其中的真實感。所以，在第五章的線上案例可以看到都使用虛擬實境的技術，來建構數位城市的空間，營造使用者在空間中的真實感受。而且由於認知圖繪是一種心理裝置，能自動再現空間並進行探路的能力；因此，地圖的提供變成是數位城市最重要的認知圖繪呈現方式。另外，為了讓使用者能在數位城市中互動溝通，以延伸真實空間的生活關係，通常在圖形界面中會有互動參與的對話框設計，來塑造場所感覺。所以，在超媒體空間中，數位城市的圖形界面需考慮兩方面，網路的視覺媒材技術以及空間瀏覽的輔助。

一、網路的媒材技術

1. 建構數位城市的媒材技術主要是綜合環場影片、三維模型、地理資訊系統以及虛擬實境，作為呈現空間意象的再現工具。
2. 圖形界面的空間性媒材，必須考慮空間感的全正數相關性因子，位置移動、動態影片、視景轉變、立體物件、透視、層次、光影與背景音樂等八項，作為傳達空間屬性與感知的基本條件。

3. 數位城市透過電子白版、對話匣以及城市攝影機的即時動態資料擷取與電訊資料的技術整合，來延伸真實社會的溝通與活動。

二、空間瀏覽的輔助

1. 界面作為提供感知的回饋訊息，其重點在互動的視覺、輸入與輸出裝置。因此，圖形界面主要會有三個部分：空間瀏覽區、對話互動區、連外資料區，以保持空間覺察的連續性。
2. 認知圖繪的表達以地圖、鳥瞰圖以及三維模型的透視圖，來作為數位城市的整體空間認知。
3. 地圖能提供自我座標、空間架構以及方位的關係，避免迷失方向並減低空間認知的負荷，因此在數位城市中是最佳的空間瀏覽輔助。
4. 龐大的數位城市在尺度上會片段化成許多小區域，透過地圖搜尋與點選的方式，來連結到空間的環場影片、三維模型以及虛擬實境，協助使用者在有限的視域中瀏覽空間。
5. 在數位城市中透過虛擬實境的界面工具，以鍵盤及滑鼠在方位、上下及高低等符號，來進行數位城市空間的瀏覽運動。



6.1.3 瀏覽探路的經驗轉換

在數位城市的虛擬環境中，因為視域的限制以及空間尺度的縮小與片段化，造成在定位與形成整體空間感要花費較多的時間。所以，如果要在一個不熟悉的數位城市中去發展認知圖來瀏覽探路，則我們必須要能去定位與直覺地瀏覽空間。這也是數位城市在圖形界面上選擇地圖呈現與虛擬實境的重要原因；因為地圖能定位並指導方向，而虛擬實境的空間能直覺地瀏覽。從第三章的研究中顯示，在虛擬環境中的空間知識是來自於真實空間的瀏覽經驗轉換；因此，數位城市中的瀏覽活動必須透過認知圖與空間知識，以及圖形界面中自明性與可意象性元素的支援。而在第四章的媒材認知實驗，更進一步指出視覺是數位城市中最重要環境感知形式。在網際環境中所使用的超媒體技術，正是透過視覺形式（visual modality）的界面，來呈現一種空間認知的凝視旅行。而在第五章的案例研究中顯示，在數位城市中瀏覽，其空間形式並不需要像真實城市的幾何空間一樣；但卻是需要透過像真實城市一般的自明性來使瀏覽容易；換句話說，虛擬空間需要利用人類之空間知識的先驗心理模型，亦即認知圖繪中的地標、路徑、節點、區域與邊界，來拓樸數位城市中的空間想像與瀏覽。由於人與空間的學習關係，在實體環境中是在實際空間中（inside）來瀏覽與學習；而在數位城市中是在再現空間外（outside）

來瀏覽與學習，而且必須透過視覺與界面。另外，數位城市的建立基本上是要延伸實體環境中的生活經驗到虛擬環境。因此，在數位城市中的瀏覽探路的經驗轉換，可從真實環境與虛擬環境的差異與生活經驗的延伸來看：

一、真實環境與虛擬環境的差異

1. 內容：實體空間是以實體物體來提供感知；而數位空間中是以視覺、聲音與文字的資訊編碼來製作感知物件。因此，數位城市透過環場影片、三維模型、虛擬實境及沈浸式虛擬實境的清晰視覺編碼提供空間的感知，並以化身來連結身體的資訊，增加空間認知的強度。
2. 結構：實體空間結構的改變較慢；數位城市的空間具動態性，可被使用者即時操作。而實體空間中的城市、地景及人造物可提供使用者熟悉的操作與想像，就像案例『虛擬城市』的虛擬空間一樣，導入真實空間的隱喻（三維透視圖），讓使用者藉由界面操作（像zoom, pan, go to, open, and enter）獲得具階層性的多重尺度之視野控制，簡化真實與虛擬環境之間的瀏覽經驗轉換。
3. 視覺參考：突出的視覺參考在實體空間是地標；而在數位空間中可透過特別的圖示（icons）、亮點的光影變化及簡化後的量體，來作為視覺參考地標。
4. 瀏覽進程：人類基本的空間能力可在連續性的探路策略中回想移動的連續記憶。而在數位城市中，透過探路的直覺式視覺輔助，如靜態圖表、地圖與方向的視覺選擇、追蹤操作的紀錄以及虛擬實境的視點選擇工具，數位空間的瀏覽經驗一樣會記住位置的連續關係。

二、生活經驗的延伸

1. 社會的互動溝通：在真實環境中，空間是作為社會性溝通的容器；而在數位城市中亦有居住與社會痕跡的空間互動現象。在數位城市中為了延伸實體空間中的活動與生活的共通經驗，會在界面中導入人際溝通的空間經驗，如文字對話框、電子白板及視訊對話的設計，來創造面對面的溝通經驗，就像『虛擬赫爾辛基』將電信與地址嵌入三維模型中，提供查詢與溝通。
2. 城市資訊的延伸：在數位城市中會將真實環境的活動，如文化、公眾、學習、商業、旅遊等服務資訊，整合到圖形界面的資訊空間中，就像『數位城市京都』過透查詢交通資訊後，界面能顯現交通物件在地圖上的移動。
3. 行為的情緒模擬：在數位城市中為了呈現真實的人際溝通行為，會透過化身來模擬身體在真實空間中的行為，就像『活躍世界』提供化身的視景轉變以及動

作的表情符號。

4. 場所感的營造：人類的記憶依賴空間的安排與配置，而空間經驗緊連視覺與聽覺的感知。因此，在數位城市中場所感的創造，除了利用視覺化的空間階層結構，如節點的環場影片及路徑的虛擬實境瀏覽；還可以利用聲音來營造環境認知的記憶線索，就像『活躍世界』將聲音事件嵌入虛擬環境中，提供立體的環境聲音作為模擬真實空間的聽覺經驗。

6.2 貢獻

上述理論模型的三類特徵是透過實體城市、數位城市與超媒體界面三者之間的空間認知關係，來分析探討數位城市在視覺性的空間意象與感知，並整合記憶、空間知識與網際空間認知研究取向三者的理論基礎背景，建立實體與數位空間的認知理論模型，來轉換並解釋超媒體空間的場所認知。其主要貢獻有下列四點：

1. 建立數位城市的空間認知關係：本研究以認知理論為基礎的網際空間研究方法，提供數位城市在視覺性界面的空間認知模型，有助於瞭解人類在網際空間與實體空間中的認知轉換經驗。
2. 建立數位城市的空間性視覺性因子關係：透過認知實驗建立數位城市在圖形界面的空間因子，與認知記憶及網際環境知識的關係，提供數位城市在超媒體空間中視覺性因子的設計參考。
3. 數位城市可作為規劃設計的教育新領域：透過將實體空間中的瀏覽經驗整合到網際環境中，本研究提供在數位城市的超媒體空間瀏覽時，所需的空間知識與視覺性的空間性因子，可作為數位城市在設計教育的參考。
4. 數位城市是實體與虛擬環境的共構：數位城市是作為延伸真實環境的生活經驗，本研究指出透過圖形界面的空間性隱喻與社會性的溝通科技，可將實體城市與數位城市連結在一起。

6.3 限制

本研究只專注數位城市在視覺性的空間認知因子探討，與網際環境中空間知識與認知記憶的關係，在研究方法與過程有以下四點限制：

1. 認知實驗只探討實驗對象在不同媒材的空間認知結果，並不探討專業訓練的

差異所造成的認知異同關係。

2. 網際空間的認知模型並不是一個數位城市中的瀏覽探路模型，而是網際環境的空間知識、圖形界面與記憶過程的關係說明。
3. 研究聚焦在認知活動的視覺感知，對於聽覺的空間感知並不研究，因此在數位城市的界面探討也止於視覺圖像，不涉及聲音與互動硬體所形成的聽覺及觸覺的空間感知議題。
4. 線上數位城市的案例研究，並無長時間觀察網站的變化，是否在圖形界面上趨同於本研究的理論模型；亦無從網路的媒材及通訊科技的層面，來討論在數位城市界面的影響及感知呈現的問題。

6.3 未來研究

本研究是透過空間認知來探討網際環境中所浮現的數位城市，並將焦點放在視覺性的界面。除了引用實體城市的空間理論外，還透過認知理論、城市意象、認知圖與超媒體空間的特徵，來探討數位城市在空間認知的關係以及在視覺表現的空間性因子。

透過網際空間認知模型（圖4-34），說明數位城市的空間知識與實體城市的差異，以及圖形界面在視覺性因子的考量所需注意的三點（參考p.83-84），並將認知記憶的過程整合到數位城市的空間瀏覽經驗中。因此，對於其中所涉及數位空間或虛擬環境的其他研究如：虛擬環境設計、超媒體空間瀏覽、空間知覺與認知、視知覺與圖形界面、經驗類比、空間隱喻、場所經驗等 (Bridges and Charitos, 1997; Darken and Peterson, 2001; Freksa et al., 2000; Osberg, 1993; Wong et al., 2001)，大多只是先前研究中論及並引用而已，並無深入探討。所以，針對本研究在數位城市的視覺性界面，其未來的可能議題，有下列六個方向：

1. 從本研究的網際空間認知模型，在空間知識、圖形界面與記憶過程的關係中，更進一步地發展成在數位城市中的瀏覽探路模型，來轉換實體環境的空間瀏覽經驗。
2. 透過虛擬環境的認知實驗，找出與實體環境中不同的空間感知因子。
3. 從網際環境中的定位與方向研究，來探討網路科技與媒材工具，如何協助數位城市建立『通用界面』，以延伸實體環境中的空間經驗與行為。
4. 從數位城市作為延伸實體環境的生活感知，來探討在網際環境中，社會性互動

溝通的可能面向，以及網路科技與媒材工具在其中的影響。

5. 數位城市的場所認同感與隱喻轉化的空間對應，如何透過圖形界面與空間性因子來呈現。
6. 記憶、聲音與視覺圖像的關係，如何影響人類在超媒體空間中的空間感知與認知圖繪的形成。



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