

GIS for Architects: Exploring the Potentials of Incorporating GIS in Architecture Curriculum

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ABSTRACT: Geographic Information System (GIS) has significant potentials to contribute in contemporary architecture education. GIS techniques are increasingly used in both realms of research and practice; especially in the fields which deal with spatial concerns, like geography, earth and mineral sciences, landscape architecture, etc. Unfortunately, GIS is yet to be conceived as an important content in the global trends of architecture education. Very few schools have incorporated GIS in their curriculums and the conceptual connection between architecture and GIS is yet to be explored.

In light of their experiences of developing a graduate GIS course for an architecture school, authors of this paper discuss a feasible way of incorporating GIS contents in the architecture education system. The course is intended to provide students with a foundation for reading, understanding and using basic GIS techniques which are relevant to architectural research and/or practice. Main objective of the paper, however, is to establish a bridge between the two conceptual realms - architecture education and GIS. It is understandable that without defining the conceptual connections between GIS and Architecture, the intended course cannot fully achieve its goals. This paper tries to deal with this challenge by defining the course objectives that address the needs of GIS for an architect.

The field of architecture, both in terms of practice and research, may be benefited by GIS. In the changed context of emerging practice and thinking in architecture, GIS has the potential to contribute in the restructured knowledge and praxis taken in the re-disciplining of architecture education. A fully dedicated GIS course for architects can be an important step towards this re-disciplining process.

KEYWORDS: GIS, architecture education, curriculum development, course objectives

1.0 INTRODUCTION

Is GIS relevant for architects? Why do architects need to learn GIS? While briefing the history of *Geodesign*, author William R. Miller retold the famous story of Frank Lloyd Wright's designing of the Fallingwater (Miller 2012). Wright completed the entire design concept, including floors plans, elevations, sections, and a quick perspective within just three hours; the time Edgar Kaufmann Sr. (the client) was on his way to Wright's studio near Spring Green, Wisconsin (Toker 2005). Wright had the site's geography and its rich layers fully in mind while he was doing the design, giving consideration to topography, the location of the stream and waterfall, the placement of boulders that provided the foundation for the house, views to and from the house, and site-related environmental conditions such as the use of solar access for heating the house in the winter and cold air flow along the stream for cooling the house in the summer (Miller 2012). As the masterful architect dealt with so many layers of geographic information simultaneously, Miller (2012) finds it to be similar to the processes of GIS based design or *Geodesign*. Transparency is an inevitable part of architects' drawing sheets which enables them to envision the complex layers of existing site features while laying out the new designs. This phenomenon is almost similar to the principal concept of GIS known as graphical overlay technique. It is not surprising that many of the pioneers behind the conceptual development of GIS are either architects or landscape architects.

Today, GIS is not just about the topography or land-use patterns. It offers a dynamic way of representing unseen patterns of socio-cultural, socio-economic, behavioral or demographic data and their contextual relationships across a regional area. As mentioned by Nicholas de Monchaux, an architect, urbanist, and professor at the University of California, Berkeley, the modern world is moving from a place where it was hard to find information to where we are flooded with place based data (Zeiger 2010). Spatial data are increasingly being available over internet and they are often free or very low in cost. In this present context of data availability, GIS offers architect so much more than just base maps or site diagrams. It allows architects to make informed decisions based on real world data. GIS enables architects to answer complicated questions like 'How can we use our buildings more effectively?' or 'Does a building need to be built at all?' It is now inevitable that GIS technology, long relied on by planners, is making its inroads into architecture.

1.1. Why GIS for Architects?

It is a matter of great significance how architects respond to this changed context of data availability and increasing popularity of GIS based analyses and techniques. GIS has many potential uses in architectural research and practice, especially in the areas of urban design, community planning, and the site selection processes. At the high end, GIS techniques are used in cutting edge designs by architects in visionary projects like the planned city of Masdar in Abu Dhabi which is driven by solar and renewable energy and is totally sustainable—zero carbon, zero waste (Zeiger 2010). GIS can also be used in conjunction with other visualization tools, such as AutoCAD, Google Earth, Adobe Illustrator, and Google Sketchup, to create dynamic and complex models. The benefit of GIS lies in its analytical capabilities, wherein multiple phenomena can be linked by location and viewed through a spatial lense. Information on an area's geology, soil type, infrastructure, and demographic information, for example, can all be taken into consideration when planning a structure or selecting a site (Moore 2013). However, in both realms of practice and research, architects adopting GIS techniques are still a rarity.

Architecture curricula need to respond to this growing need of GIS education for architects. Developing new GIS courses in architecture is a need of the time.

1.2. Present Trend of GIS Education in Architecture: Understanding the Challenges

GIS is conceived to be an important content, but it is still not treated as an integral part of the Architecture curriculum. There is little or no GIS content in most of the architecture programs all around the world. Even programs which incorporated GIS in their curriculum often show lack of enthusiasm to establish the conceptual connection between GIS and architecture.

The following four challenges are identified as reasons of the present trends of reluctances and lack of enthusiasms to incorporate more GIS contents in architecture education.

- a. Architects intuitive nature: Architects are often intuitive but their decision making processes are not always based on data. One of the biggest challenges of adopting GIS into architecture is getting architects to think about data as part of a creative decision-making process and to translate geospatial analysis into built form (Zeiger 2010).
- b. Lack of interdisciplinary research in architecture: The prime characteristic of GIS enquiries is their interdisciplinary nature. GIS has the capacity to reveal spatial patterns of not only geographic data, but also demographic, socio-cultural, socio-economic, criminological or even behavioral data. This interdisciplinary notion in research is often absent in architecture research. Instead of collaborating only with technical schools of engineering and construction, Architecture Education should also look forward to interdisciplinary research with relevant other disciplines like sociology, psychology, behavioral studies etc.
- c. Dominance of technical research in GIS: Architecture alone should not be held responsible for the lack of GIS based contents in its curriculum. GIS is dominated by technical research and by uncritical accounts of application. The available literature is

not only limited in extend, but also biased towards the implementation of GIS, rather than the effects of its use on the host organization (Craglia 1992).

- d. Failure to understand the conceptual connections between GIS and Architecture: GIS contents should not be just dumped into the intense curriculum of architecture. Like any other interdisciplinary course, the needs of GIS for an architect must be realized and this realization should be reflected in the course design. Course objectives and assignments should be formulated accordingly to articulate architectural design or research problems through GIS. GIS course contents should be grounded in the needs of an architect. Otherwise, the course would never acquire its mission of producing data awareness among students of architecture.

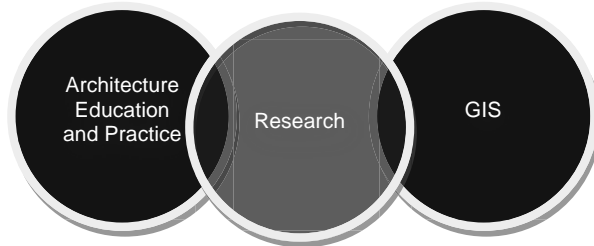
2.0 CONCEPTUAL FRAMEWORK

It is essential to establish conceptual connections between GIS and Architecture Education. This process can simply start by looking into the broad definitions of the two domains. Table 1 contains the broad definitions of Architecture (Merriam-Webster 2013) and GIS (ESRI 2013). The primary difference stated is that, architecture is a design process while GIS is a way of analyses.

Table 1: Definition of Architecture and GIS

Architecture	GIS
1. The art and science of building, <i>specifically</i> : the art or practice of designing and building structures and especially habitable ones	A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

Conceptual Level



Operational Level

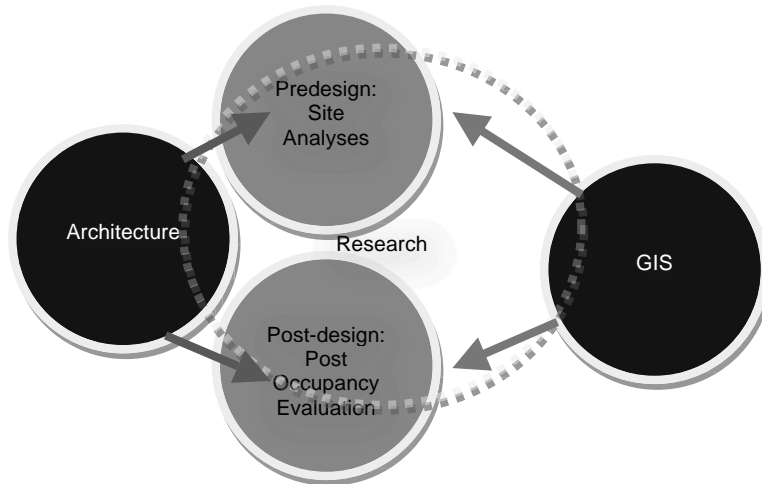


Figure 1: Research is a critical domain to connect GIS and Architecture Education

In the conceptual level, a third domain *Research* is introduced to integrate GIS in the process of Architecture. The scope of research in the pre-design phase and post-design phase can be benefited by adopting GIS techniques. For example, GIS can provide rich and holistic analyses of a site or can be used to identify the most efficient site location/s of a proposed building in an urban landscape. Similarly, GIS techniques can also be used in the post occupancy evaluation/research of a building or a city. For example, GIS based behavioral mapping of a designed environment can predict users' preferences and guide/evaluate design decisions. It should be kept in mind that GIS is not a tool for designing, rather a collective way of analyzing and recording spatial data. Research is the holistic framework to integrate GIS in the process of architecture education and practices.

3.0 THEORETICAL PERSPECTIVES

Three different theoretical perspectives are revisited which are closely related to architecture/design. It is assumed that these theoretical perspectives have potential contents to merge GIS and Architecture studies and will exemplify the process of conceptualization. It should be kept in mind that there may be many more different theoretical perspectives in architecture and other disciplines, which can be successfully used to constitute the relationships between these two spheres of knowledge.

3.1. Owen's Design-Research Paradigm

Since architecture is a process of design, and research in architecture is considered as the key of incorporating GIS contents in Architecture education, Owen's diagram (Figure 1) on design research (Owen 1998) can be revisited to understand the reciprocity of the two realm of research and practice in the fields of design. In a series of flow diagrams, Owen showed how *Design Research* and *Design Practice* interplay in one continuous process of knowledge making.

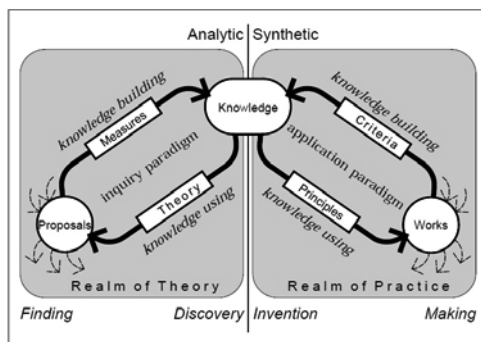


Figure 2: The continuous process research and practice in design (Owen 1998)

This theoretical perspective with illustrated design-research continuum can be a useful starting point for designing a GIS course for architects. This diagram can be modified or even extended to provide a broad theoretical perspective for the proposed course of GIS for architects.

3.2. Roger Barker's Theory of Behavioral Settings and Behavioral Mapping

Behavior setting has been applied for decades as a useful construct in environment-behavior research. Behavior settings are ecological units where the physical environment and the behavior are indissolubly connected. These eco-behavioral units were first described by Barker (1976). Behavior settings have a clear structure: they are located in time and space, they are composed of entities and events (people, objects, and behavior) and other processes (sound, shade, etc.), their spatial and temporal boundaries are identifiable. The most significant characteristic feature of this concept is that, it offers researchers to study the reciprocal relationship between environment and behavior.

The method that is most comprehensively aligned with the concept of behavioral setting is known to be Behavioral Mapping. It allows a researcher to measure or evaluate a physical environment in terms of activities and behavior. This concept can be very useful for formulating course contents and assignments for the proposed GIS course for architects. GIS based behavioral mapping has the capacity of evaluating a designed environment in terms of contextual behavior. This method can be used for post occupancy evaluation/research in architecture by using GIS based strategies.

3.3. Defensible Space

The central tenet of Newman's defensible space is that the physical design and layout of urban living environments are a principal factor that determines why some places are more vulnerable to crime than others (Newman 1972). With this principle, the crime–design thesis offered an exclusive selling-point, because it emphasized the fact that the built environment is more easily manipulable than the sociological context, making it a potentially more fruitful angle from which to tackle crime prevention at place (Reynald and Elffers 2009). Newman's defensible space concept refers to the systematic way in which the physical design of urban residential environments can be manipulated in order to create spaces or places that are less vulnerable to crime by providing residents with more opportunities to control their space and defend it if necessary. To the authors' understanding, this concept has a lot to offer for the proposed course design because it explores the relationship between designed environment and human behavior.

In spite of its durable contribution and continuing influence in the field of criminology, Newman's theory has been criticized as extensively as it has been influential (Reynald and Elffers 2009). Newman's defensible space is often criticized to be merely a 'fashionable consensus' rather than a set of empirically robust concepts that effectively prevent crime. GIS based research in architecture can counter these criticisms by providing empirical evidences of relationship between designed environment and real crime data. Figure 3 illustrates a similar research conducted by one of the author where signs of incivility were plotted to understand their relationships with the usage pattern of visitors in a recreational park in Raleigh, North Carolina.

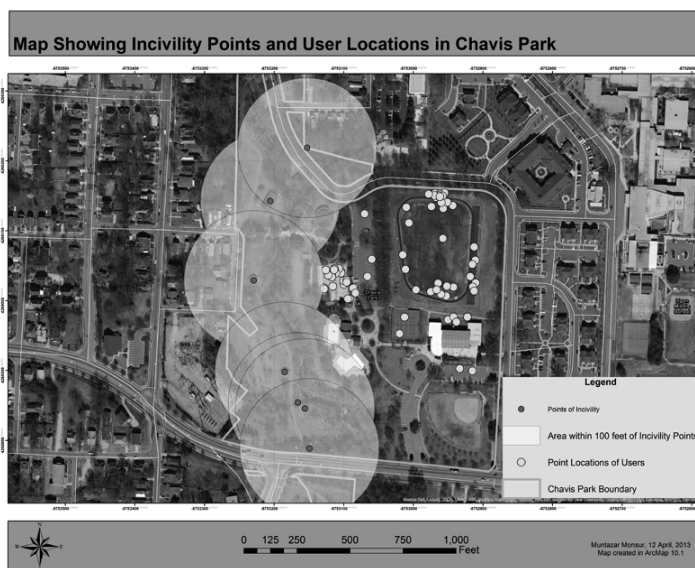


Figure 3: Author's study of mapping incivility points in a recreational park to understand how signs of incivility are related to the usage pattern of the park area

4.0 THE COURSE IN A NUTSHELL: GIS FOR ARCHITECTS

The conceptual framework of the study and the different theoretical perspectives discussed above provides the ground work for constituting a GIS course for architects which will attempt to connect the two different conceptual spheres of architecture education and GIS.

4.1. Course Description

The course introduces the basic concepts and techniques of GIS (Geographic Information System) to architecture students. It is intended to provide students with a foundation for reading, understanding and using basic GIS techniques which are relevant to architectural research. The course will be conducted in two basic segments. In the *Theoretical* segment, students will explore the principles of GIS - what it means, how it is linked to design research and its potential usage in the contemporary world to conduct spatial investigations. In the *Application* segment, students will be assigned with small GIS based research tasks which would require them to use single or multiple strategies based on the complexity of the given problems. Learning from both the theoretical and application segments will be incorporated in a final project where students will be asked to generate their own architectural research questions and demonstrate GIS skills for collecting and analyzing data to answer their questions. Course readings cover major GIS concepts and techniques and present samples of recent articles from major journals and dissertation theses which used GIS techniques to answer architectural research questions.

4.2. Course Objectives

By the end of the course students will

1. Be acquired with a knowledge base on the broad range of GIS principles and applications in the domain of architectural research.
2. Obtain an ability to choose the appropriate strategy/strategies from the wide range of GIS techniques and apply them to answer specific architectural research question/s.
3. Demonstrate their understanding on how GIS can be effectively used to answer research questions in architecture.
4. Acquire an ability to transform a spatial research investigation into an effective research design, ranging from data collection to data analyses by using appropriate GIS techniques.
5. Be able to use common terminology in discussions of various GIS based strategies relevant to architectural research and practice.

4.4. Three Conceptual Assignments for the Course

Once the course objectives are defined, the next step is to formulate thematic research problems (in architecture) which can be answered by GIS techniques. Three conceptual problems are described below which can be refined and adopted as assignments for the proposed course. These problems represent only a few examples of GIS based tasks which may relate to architectural problems. It should be kept in mind that there can be a thousand different assignments similar to these. The most important thing to keep in mind for designing assignments for the proposed course is to ground GIS based techniques to architecture oriented problems or questions.

4.4.1 Site Analysis

Instead of a mere thematic site analysis, students may be asked to perform a comprehensive site selection process which involves critical geographic and other conditions.



Figure 4: A critical site selection process with multiple complex conditions (Author)

For example, in Figure 4, the map shows a complex site selection process for a childcare center in the main campus area of North Carolina State University (author). Teachers may provide students with imaginary or real life conditions for the selection of the most suitable site/s, for example – the sites cannot be within 500 feet of any hazardous building, or they should be in proximity (walking distances) of any campus bus stop. When teachers introduce multiple and complex conditions like these, it will require the students to explore the potentials of data interpretation to answer geographic questions. Instead of merely drawing a base map, students will get an essence of real world complexities of site selection and site analyses.

4.4.2 Behavioral Mapping for Post Occupancy Evaluation

Behavior mapping is an objective method of observing behavior and associated built environment components and attributes. It provides researchers with an innovative method of assessing behavior linked to detailed physical characteristics of indoor and outdoor areas (Cosco, Moore, and Islam 2010).

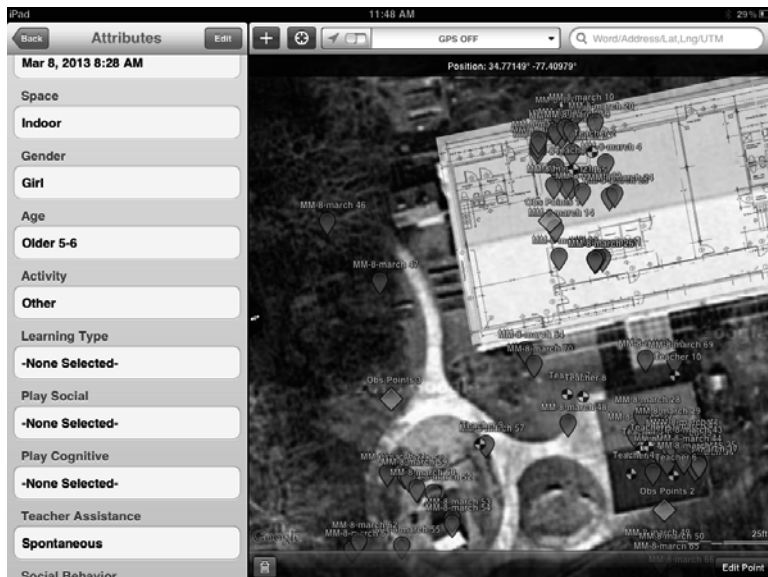


Figure 5: Behavioral Mapping can predict behavioral variation linked to designed environment (Author)

Traditionally, behavioral mapping has two distinct parts – *mapping* allows a researcher to map the point location of the subject on a base map and *coding* records all the attributes of the subject. The *coding* part is flexible and designed as per the direction of the research question. However, with latest advent technologies, mapping and coding can be done simultaneously in touch sensitive electronic devices (Figure 5). Teachers may formulate an assignment in which students will gather behavioral mapping data in a designed environment and present their predictions about the design in GIS maps based on usage patterns.

4.4.3 Testing Defensible Space Theory by Crime Data

As discussed in 3.3, assignments can be formulated in which students will select a manageable land parcel in an urban environment and evaluate the physical design in terms of Newman’s three characteristics of *defensible space* – territoriality, natural surveillance and image/milieu. Later students will plot real crime data to test defensible space theory with empirical evidences.

5.0 CONCLUSION

This paper merely attempts to identify the vast possibilities of intelligent course design which would emphasize GIS contents in architectural education. It tries to draw attention to the fact that innovative approaches can be applied to establish conceptual connections between GIS and architecture which would result in meaningful course content that would establish strong ground for GIS based education and research in the domain of architecture.

The field of architecture, both in terms of practice and research, may be heavily benefited by GIS. This paper tries to introduce the construction of a knowledge base on the broad range of GIS principles and applications in the domain of architectural research. It may contribute as an eye opener towards a discussion which is crucial in the reform and restructuring of architectural education in the changed context of thinking and practice. Architecture education has long been criticized for not having enough research contents in its curriculum. New courses should be developed to address this lacking. Incorporating GIS courses may contribute towards the structuring of a new genre in architectural research.

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