

Integrating Hedgerow into Town Planning: A Framework for Sustainable Residential Development

Siqing Chen

Abstract—The vast rural landscape in the southern United States is conspicuously characterized by the hedgerow trees or groves. The patchwork landscape of fields surrounded by high hedgerows is a traditional and familiar feature of the American countryside. Hedgerows are in effect linear strips of trees, groves, or woodlands, which are often critical habitats for wildlife and important for the visual quality of the landscape. As landscape interfaces, hedgerows define the spaces in the landscape, give the landscape life and meaning, and enrich ecologies and cultural heritages of the American countryside. Although hedgerows were originally intended as fences and to mark property and townland boundaries, they are not merely the natural or man-made additions to the landscape—they have gradually become “naturalized” into the landscape, deeply rooted in the rural culture, and now formed an important component of the southern American rural environment. However, due to the ever expanding real estate industry and high demand for new residential development, substantial areas of authentic hedgerow landscape in the southern United States are being urbanized. Using Hudson Farm as an example, this study illustrated guidelines of how hedgerows can be integrated into town planning as green infrastructure and landscape interface to innovate and direct sustainable land use, and suggest ways in which such vernacular landscapes can be preserved and integrated into new development without losing their contextual inspiration.

Keywords—Hedgerow, Town planning, Sustainable design, Ecological infrastructure

I. INTRODUCTION

HEDGEROWS are spontaneous or planted structures such as rows of trees or shrubs. While in the past hedgerows served an important function on the farm as living fences and boundary, today hedgerows are highly regarded primarily for their ecological and cultural values [1]. Hedgerows are particularly valued for their function as wildlife habitats. Increasing interest in hedgerows as a means for enhancing biodiversity has led to an emphasis being placed on their value for sustaining wildlife, particularly in largely agricultural landscapes [2]. The word “hedge” itself is believed to be of Anglo-Saxon origin [3]. These words have given rise to our modern usage: *haeg*, *hega* and *hecg*. *Haeg* means hurdle and *haeg* is the base for hay; *hega* means a living or border

boundary and *hega* is the origin of the modern “haw”, as in hawthorn, which is a key hedgerow species in England. *Hecg* means a territorial boundary either dead or planted. *Hecg* has given rise to our modern “hedge”. Historically, the development of hedgerow experienced three stages. In the first stage, hedgerows were in the form of dead hedge, e.g. stone wall, wood/log pile-up, etc. The second stage was to replace dead hedge with living hedge, and hence the real sense of meaning of hedgerow today. The living hedge may already have been in existence in the 12th century [4]. In the Medieval period, before the enclosures, hedges had a variety of functions. They provided a stock-proof barrier and a shelter for stock, a boundary marker for fields and farms, as well as a source of fodder, timber and fruit [3], [5]-[7]. Hedgerows have developed in response to the inherent physical and biological character of a region, in conjunction with cultural factors. Traditionally, hedgerows were an important source of wood as well as other products, although such functions are in decline in many regions. They still have an important role in the landscape for soil protection and act as barriers and boundaries between management units [1] [8-11].

The vast rural landscape in the southern United States, from middle Texas to east Alabama, is remarkably characterized by the hedgerow trees or groves (Fig. 1). Hedgerows form a series of network of patchwork, creating a landscape of low fields surrounded by high hedgerows. As mentioned above, hedgerow’s primary function in the landscape is to serve as limits, marking boundaries and borders. However, hedgerows can also provide products for human in his pursue of food, clothes and shelters. The improvement of the visual quality and authenticity of the rural landscape is another important function of hedgerow. Many of the functions of hedgerow can be assessed in the relationship of one another. Hedgerows are important habitat for wildlife such as bird, mouse, butterfly, etc. Meanwhile, hedgerows functioning as ecological corridors maintain the connectivity of the landscape; thus hedgerows are important to protect and improve the biodiversity. Hedgerows not only give a strong sense of place in the rural landscape but also invite an intimate emotional association with the American countryside.

In the process of seeking food, fiber and fuel throughout human history, each of us inherits in the built and natural environment a legacy and responsibility – we are charged with

Siqing S. Chen is with the Faculty of Architecture, Building and Planning, University of Melbourne, Parkville, VIC 3010, Australia (phone: +61-3-8344-8582; fax: +61-3-8344-5532; e-mail: chens@unimelb.edu.au).

managing environmental changes so that ecology, economy and culture are sustained and advanced. The key to this, from a landscape designer's perspective, is to treat each planning decision as an important part in a cumulative chain of events. However, urbanization characterized by the ever expanding real estate industry and high demand for new residential development has jeopardize the existence of authentic hedgerow landscape in many rural areas.



Fig. 1 The hedgerow landscape. (a) Hempstead, Texas; (b) Oakdale, Louisiana; and (c) Auburn, Alabama

At the same time, riding on the tide of our technological advancement have come ecological catastrophes and tremendous challenges involving water quality and supply, air quality impacts, climate change, energy resources, toxic materials, biodiversity loss, and many other issues. On one hand, the term sustainability is overused and sometimes abused by politicians, academic leaders and corporate public relations representatives, that is, those who hold economic and political power today. On the other hand, people and organizations that focus on short-term benefits often control the forces of technology and growth and bottom line profits rather than sustainability and stewardship. Taking Hudson Farm-a suburban residential development project outside Montgomery, Alabama-as an example, this paper explores the key principles and guidelines for sustainable town planning based on the site's physical condition, historical background and future challenges.

II. HUDSON FARM MASTER PLAN

A. Hudson Farm

The Black Belt. Hudson Farm is located right on the Black Belt. The Black Belt is a region of the southeastern United States. Originally the term describes the prairies and dark soil of central Alabama and northeast Mississippi, however, it has long been used to describe a broad region in the American South characterized by a high percentage of African Americans. It is regarded that the Black Belt covers large areas of Central Georgia, North Florida, Western Mississippi, South Central Alabama, East Central Louisiana, Eastern North Carolina and Southeastern Virginia (Fig. 2a).

At the time of European settlement, the prairie soils of the Black Belt had a thick surface layer of "sod," a mixture of the roots of grasses and forbs, with the organic matter from dead plants and animals that had built up over millennia. Deep, spongy and rich in nutrients this soil was "prime agricultural soil." The sod layer-both created and held in place by the dense root systems of the native grasses and forbs-allowed water to soak in and recharge ground water, and the black belt soil was good for growing cotton without adding any

fertilizer. When the sod was broken by the plow this retentive surface layer was lost. With cotton farming and the practice of maintaining weed-free rows, large amounts of soil were eroded and deposited in the valleys and streams. Presently the land is used for cattle ranching. Shallow-rooted European grasses grow on an impoverished soil with little or no organic layer, exposing the clayey sub-soil. This sub-soil is very susceptible to drying out and cracking and can be very slippery when wet. This phenomena common to most clays is known as "shrinkswell" and effects water absorption, the bearing capacity of the soils and the establishment of vegetation. The Hudson Farm is on the tall grass prairie, the black belt, which was used to grow cotton during the colonial years. The black belt was well known for growing cotton without applying any fertilizer to the soil. So this area is not only geographically unique, it is also culturally unique.

Urbanization Context. The Black Belt regions used to be the backbone for the agriculture of the United States in history. However, urbanization, industrialization and infrastructure construction had taken large areas of the Black Belt land. Hudson Farm is located at the southeast suburban area of the City of Montgomery, which links with Atlanta and Birmingham through Interstate Highway 85 (I-85) and 65 (I-65) respectively, creating a big triangle urban region in the Southeast United States (Fig. 2b).

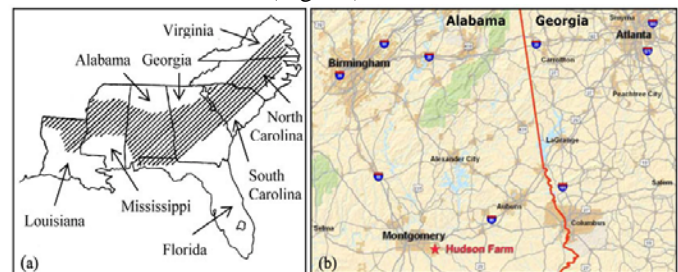


Fig. 2 Regional Context of Hudson Farm. (a) The Black Belt; (b) Location of Hudson Farm

As the biggest city in the Southeast U.S., Atlanta serves as regional center and the gate to the adjacent area. Being a neighbor to Atlanta, Montgomery plays an increasingly important role in shaping South Alabama's economic, ecological and cultural environment. Although the majority of the area southern to the city of Montgomery is used as pasture for grazing or hay harvesting, there are tremendous areas like Hudson Farm are being developed. Even there are a bunch of green areas in the region, which are municipal parks (Fig. 3), however, the region does not have any park-like area, which makes Hudson Farm the only and the last opportunity for city of Montgomery to create such a park-like place. Fig. 3 also shows the urban pattern, transportation context, and the open space of the Montgomery area. The urban core, extending with the I-85 Corridor toward Atlanta, encroaches downwards to the site, indicating the ever increasing real estate development has taken over a lot of farm land. Within the 3 mile circle, Hudson Farm was surrounded by hot waves of real estate development (Fig. 3).

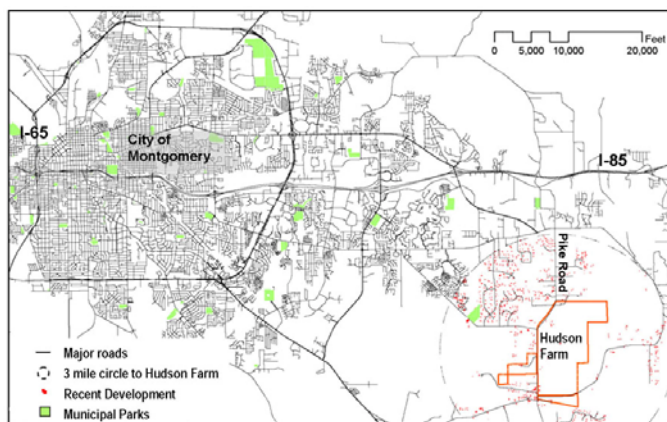


Fig. 3 Urban pattern and the transportation context of Hudson Farm

Hudson Farm. The Hudson Farm site is formed by several parcels of land totaling approximately 2100 acres. It is immediately adjacent to Pike Road, an important north-south road connection running through the City, Montgomery County, and Town of Pike Road (Fig. 3; Fig. 4). The recently adopted City of Montgomery Smart Code promotes the development of the property as a new community consisting of a series of neighborhoods which follow a set of prescribed rules based on traditional neighborhood design (TND). The Smart Code proposes that new communities be compact, pedestrian-oriented, and mixed-use, in contrast to the single-use conventional suburban development which is prevalent in eastern Montgomery area. To create whole neighborhoods and towns, rather than pockets of suburban development, is a vital step towards creating a sustainable development footprint.

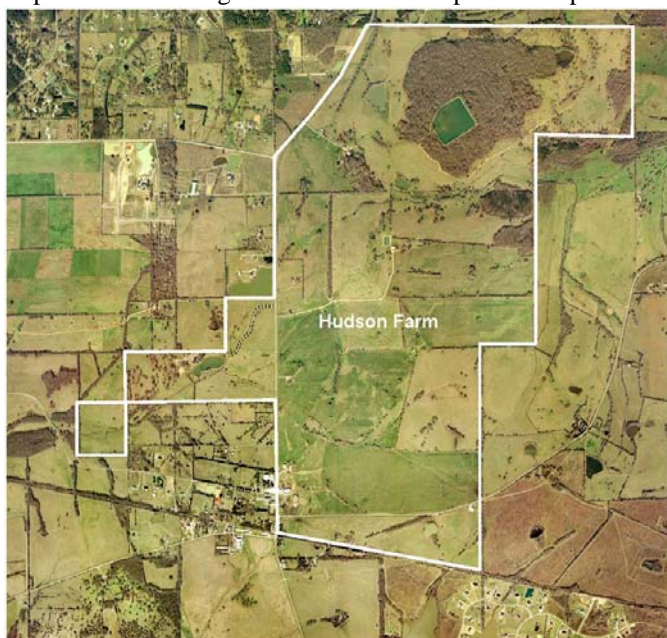


Fig. 4 Aerial Photography of Hudson Farm

Before development, Hudson Farm is used exactly for cattle grazing and hay harvesting (Fig. 4; Fig. 5; Fig. 6). The aerial photography of Hudson Farm also shows the landscape structure of the site (Fig. 4). Hudson farm is surrounded by large stream corridors in the forms of evergreen forest,

deciduous forests, mixed forests, and wetlands, which provide critical wetland habitats for migrating birds and other wildlife. The landscape elements that make Hudson Farm unique are big patches of forests, open fields, corridors in the form of hedgerows, love “landscape rooms” enclosed by high hedgerows. From a cultural landscape point of view, this landscape is of mixture of agrarian, savannah, pasture uses. The landscape of Hudson Farm gives a strong sense of place majorly because of its rural character and agricultural uses along much of the frontage of the existing roadways. The hedgerows and tress on the farm enhance the sense of place by providing refreshing long views across the open field dotted and/or enclosed by high hedgerow trees and groves (Fig. 4; Fig. 5; Fig. 6).



Fig. 5 Hedgerows on Hudson Farm



Fig. 6 The hedgerow landscape and the long view on Hudson Farm

B. Hudson Farm Master Plan

From June 20-28, 2007, I attended a design charrette to plan the future of the Hudson Farm. A team of town planners, landscape architects, architects, transportation and civil engineers finally created a master plan for Hudson Farm (Fig. 7) guided by the following ecological principles: 1) minimize the carbon footprint; 2) design for walkability; 3) attain energy self-sufficiency; 4) treat water and sewer on site; 5) maintain working agricultural landscapes; 6) create a local food web; 7) restore habitat and increase biodiversity; and 8) create multi-generational housing.

In the April 2008 Issue of the Central Alabama Business Journal an article titled “A Sense of Place” by David Zaslawsky featured the Hudson Farm Project as a headline [12]. The core values for the proposed new town are as follows.

Taking the Long View. The planning, design, and construction of the Hudson Farm Project is anticipated to last for generations. The founders are committed to staying involved and doing right by the land; realizing that extensive front end planning is key to long term success, they have assembled an interdisciplinary team of national experts in their fields to create the plan for the future.

Caring for the Land. Deep knowledge and understanding of the site will serve as the foundation for planning and design.



Fig. 7 Illustrative Master Plan for Hudson Farm (Source: www.doverkohl.com)

The best thinking and sustainable development practices will drive design, build-out, and long-term functioning of the community. More than half of the acreage will be conserved for open space and natural areas. The preservation and enhancement of distinctive “landmarks” such as trees, hollows, hedgerows, barns, and fences will maintain the site’s unique character.

Reconnecting People to Nature. The planning of the new town will provide for easy access to natural areas and multiple opportunities to experience nature. Aspects of the site’s rural will be maintained, blending the soul of the place with the soul of the people. Principles, codes, and regulations will allow for and encourage unstructured and un-programmed play and creativity in natural areas, along trails and in the many unbuilt neighborhood “edges” and connectors.

Embracing the Broader Community. The design of entrances and edges will be inviting for non-residents; public events will create a presence in the collective memory of the eastern Montgomery community. Local culture and traditions will serve as a basis for all aspects of the project, including design and amenity selection. Land use decisions on the site will be crafted with respect to local conditions, as well as with

a broader regional ecosystem context.

Creating a Model for Sustainable Community Development. Hudson Farm Project should be recognized as a precedent nationally and internationally. The timeless vernacular design of the Montgomery river region, planned to be replicated on the site, is intrinsically sustainable. Low environmental impact design treatments such as high density living areas and light imprint infrastructure will be utilized. The plan should be adaptable, to accommodate future uses and an evolving community vision.

III. HEDGEROW AS ECOLOGICAL INFRASTRUCTURE

The master plan depicts a big picture of sustainable town planning and aims to create a model for sustainable traditional neighborhood development. To explore the feasibility of establishing an “ecological town” in general and the ecological infrastructure in particular, the hedgerows on the site are studied through a design query – can they be integrated to town planning and neighborhood design as ecological infrastructure?

A. Design Concepts.

The design concepts are to rethink of the Hudson Farm plan in Fig. 7 and consider sustainable design. To achieve sustainable design one has to understand the ecology of the site, where the landscape elements and biological components are of critical importance, i.e. the clarification of the relationship between the physical environment and the biosphere, and the negotiation between man and nature.

For sustainable design, recently there is “...a call to turn the traditional practice of urban design inside out, starting with open spaces and natural systems to structure urban form, instead of buildings and infrastructure systems[13].” Thus, the established master plan may be improved by modifying its urban fabric according to the hedgerow structure. The following analysis provides a framework to achieve sustainable town planning and neighborhood design.

As landscapes are the result of complex processes and interactions between landforms, ecosystems and humans, to preserve or design with the hedgerow landscape requires understand the relationship between them. To design with hedgerow landscape is to clarify the density, composition, structure and arrangement of the hedgerow tree species and how they function together to provide eco-service. For example, when the density of hedgerows is very low, each hedgerow tree plays a key role in the visual aspect of the landscape. Many people like to see dense hedgerows when they are in the landscape and a more open space when they are at home. The importance of the view is substantiated.

At most times, the landscape is “...a mosaic where the mix of local ecosystems or land uses is repeated in similar form over a kilometers-wide area...Thus, a repeated cluster of spatial elements characterizes a landscape [14].” The basic idea of integrating hedgerow into design and planning is to create a new or modify the existing ecological processes on the land (Fig. 8).

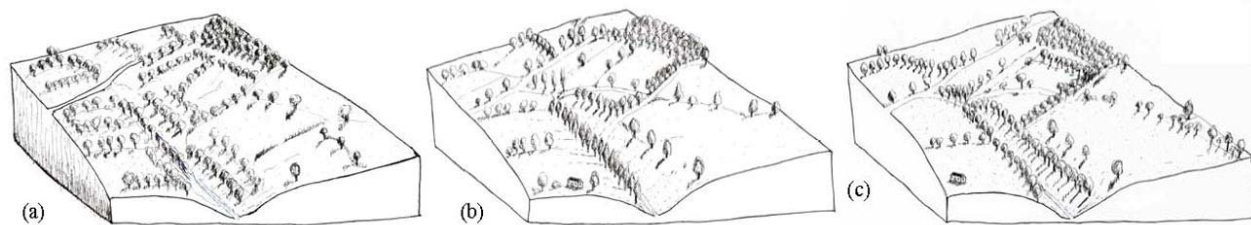


Fig. 8 Hedgerow design strategies. (a) Initial state of hedgerow; (b) Initial hedgerow landscape modified for the visual quality; and (c) Anti-erosive hedgerow landscape [15]

Fig. 8a shows the initial condition of the hedgerows. For a landscape with improved visual quality, some hedgerow trees can be removed as long as they are not on ridges, parallel to streams, or around villages. Other trees may be planted considering a desired composition and arrangement of tree species, e.g. the foliage, texture, color and smell, shape, height, etc. to improve the visual quality (Fig. 8b). The ecological processes are maintained in the bottom drawing (Fig. 8c), for example, by planting anti-erosive shrubs on the slopes to impede runoff, we can make it an anti-erosive landscape. But there is always a balance in design between these two, to negotiate between the visual quality and ecological process, otherwise it may increase erosion hazard and lead to a mismatch between land use, soil property and landscape character.

Another principle in the design of functional and healthy landscape is to maintain networks of corridors so as to allow wildlife movement through the landscape. Hedgerows must be connected, with a continuous tree cover. This concept is generally advocated by many landscape ecologists [16]-[18]. This network is superimposed on the ditch network and based on the existing hedgerows. Its spatial arrangement is related to historical factors, such as landlord-worker relationship [16,] [19]-[23].

Based on this idea, the existing hedgerows on Hudson Farm are studied (Fig. 9). To increase connectivity, some hedgerows are proposed to connect the existing hedgerows to create a hedgerow network. Basic ideas are to show why they should be connected and how should they be connected. The left diagram (Fig. 8a) shows the existing hedgerow, the diagram in the middle (Fig. 8b), the red color area, shows the proposed hedgerows. The diagram on the right (Fig. 8c) shows the overlay of existing hedgerow and the proposed hedgerow. The benefits of doing this are, from a landscape ecology point of view, that the connectivity is increased by 40% without losing much of the core habitat [24].

So how the connectivity of the landscape is increased? As motioned before, sustainable design is to “turn the traditional practice of urban design inside out, starting with open spaces and natural systems to structure urban form, instead of buildings and infrastructure systems”, the hedgerow network are ecological infrastructures of the nature system and is used to structure the urban form of the proposed town and neighborhood (Fig. 10).

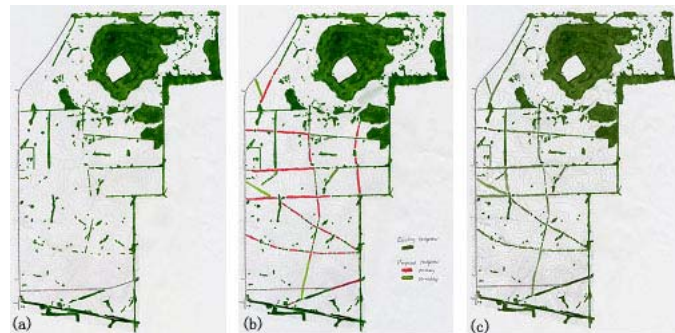


Fig. 9 Analysis of the hedgerow network connectivity. (a) Initial stage; (b) Proposed hedgerow; (c) Improved hedgerow network



Fig. 10 Using hedgerow network to structure the urban form. (a) Initial State, (b) Proposed hedgerow, (c) The fish-bone structure formed by hedgerows

B. Design Options

Based on the design concepts discussed above, a part of the property on the site was used to examine how to integrate the designed hedgerow into planning and development, by applying the proposed hedgerow to connect two existing hedgerows (Fig. 11), to create a urban form that is structured by the green infrastructure (hedgerow and forest patches), while emphasis being focused on the open spaces and natural system. There are three options to connecting the two separated hedgerow depicted in Fig. 12. Option (1): Designed Hedgerow connect straightly existing hedgerows, areas where the designed hedgerow come across was protected or used as civic space; Option (2): Move the designed hedgerow downwards to match the major street, creating an opportunity of merging the hedgerow with the roads to create a green infrastructure; Option (3): Modify option 2 to optimize the forms and the ways that the hedgerows and road coming together, but still maintain a certain redundancy of the hedgerow habitat for wildlife.



Fig. 11 Designed hedgerows is used to connect existing hedgerows (red: proposed hedgerow; green: existing hedgerow)

All the three options considered the organic structure of the proposed hedgerow, and how it would come together with the existing hedgerow. Option 1 applied a similar strategy that the existing plan used to protect the hedgerow habitat, where proposed development keeps a “safe” distance to the hedgerow habitat in general. For example, if the hedgerows are important habitat for birds, the “safe” distance mentioned above equals to the “flushing distance”. Generally the distance is about 1.5 to 2 times the height of the central canopy of the hedgerow. While Option 2 chooses to move the proposed hedgerow along the major street, Option 3 provides an opportunity to design a sustainable hedgerow street.

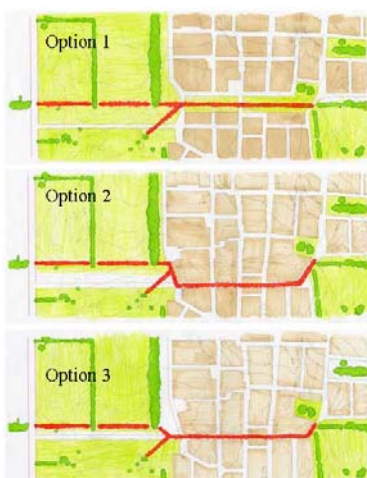


Fig. 12 Hedgerow community design options

C. Design Processes

Although the major effort in the design part of this thesis is to create a hedgerow street which serves to structure neighborhood and embodies ideas of sustainable design, the concept plan of the case study area (Fig. 13) is also important in defining the particular site. In the same time, this broader scale plan could also utilize the sustainable strategies discussed in chapters before. The first idea is to create different land use type on the study area - zones of grazing land, land Community Support Agriculture or civic agriculture, and finally the land for the town to be created (Fig. 13).

The grazing rotation area is set at a flushing distance to the hedgerows and tress on the east side to protect them from the damage of grazing cattle. The grazing rotation and the agriculture land also function as a buffer to those who enter the town from pike road, and provide an experience for those who drive along the pike road of seeing something that is not

terribly different from what is always been in there, i.e. to maintain the landscape authenticity – the rural character of the landscape. This landscape character is a critical part of the green belt of the town that forms both a green network locally and regionally.



Fig. 13 Conceptual plan of the hedgerow community, showing different land use of the site

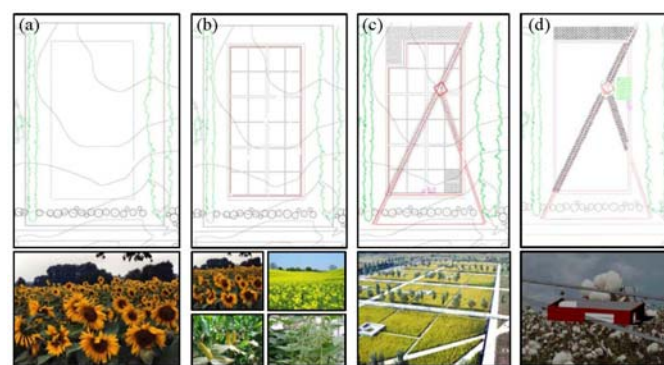


Fig. 14 Integrating hedgerows into CSA on Hudson Farm. (a) Mono-cultural CSA; (b) multi-cultural CSA; (c) Edible hedgerow and CSA; and (d) Edible hedgerow, field art, CSA and CSA education classroom (see Fig. 15 for details)

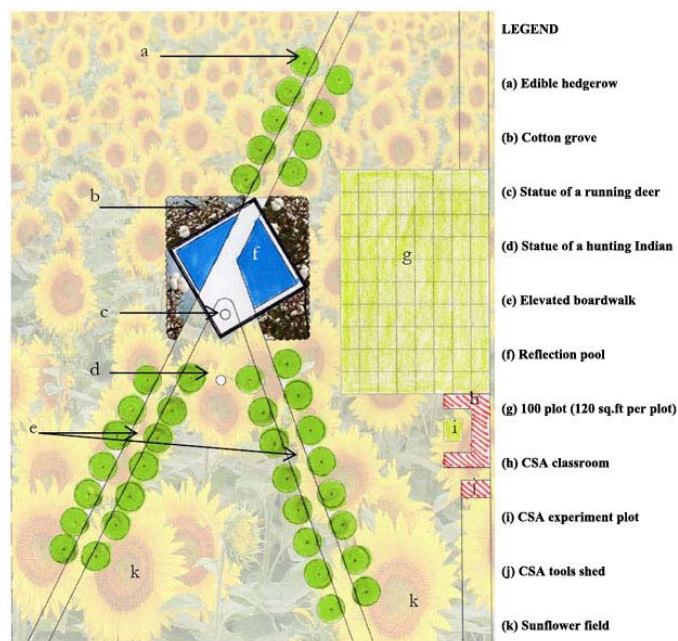


Fig. 15 The Design of the Field Art and CSA

Special consideration has been put on the form of the CSA (Community Supported Agriculture) area (Fig. 14). Since the

soil is very clay and the alkaline situations only permits very limited numbers of species to grow there, a mono-cultural landscape was proposed (Fig. 14a); and sunflower was seen growing in other part of the suburb Montgomery area. Besides sunflower, rapeseed, corn, cotton and soybean can also grow there, thus a multi-cultural CSA is also possible on Hudson Farm (Fig. 14b). By introducing edible hedgerows, for example, peach trees, as road side tree, Fig. 14c created an agriculture park, where the future Hudson Farm residents could spend much of their time. However, one of the important issues that architect and landscape architect should consider is to educate broader community about sustainable design, ideally through their own work. CSA with the art field (Fig. 14d; Fig. 15) is another way to look at agriculture in terms of its beauty, productivity and potential to be of recreational and educational use. The proposed "one hundred hand ploughed" plot (12 by 10 feet) for kitchen garden and the CSA classroom may answer the questions "What should we have for dinner" that Michael Pollen raised in his book *The Omnivore's Dilemma: A Natural History of Four Meals* [25] as well as the question "What is real food" in his recent book *In Defense of Food* [26].

IV. HEDGEROWS AND SUSTAINABLE NEIGHBORHOOD DESIGN

The term sustainability has been overused today and become meaningless. In this study I intend to exemplify sustainability by giving a case study of creating the local food web for the Hudson Farm residential development project.

A. The Local Food Web

To create a local food web is one of the most important aspects in sustainable design. The reason that local food web is critical is that generally, chickens travels 50 miles before it reach the consumer. In average, food travels around 1,500 miles total until it reaches the plate. In United States, 10 calories of fossil fuel are necessary to produce a calorie of processed food, and 20% of America's petroleum consumption goes to producing and transporting food (Fig. 16), which is not ecological, not economic and not sustainable.



Fig. 16 Food processing and transportation consumes 20% of America's petroleum

The local food web could avoid the gas consumption by food processing and transportation, and also reduces the carbon dioxide emission from the combustion of fossil fuel, hence help to mitigate the global warming. Thus a design that creates a local food web is sustainable design. However, sustainable design is not limited to create a local food web. Not so obvious contribution to sustainable design strategies

are to encourage home design to engage the outdoors for daily activities; make being in nature convenient and practical, to make the buildings climate-responsive, energy innovated, to create and educate the public for living in a multi-generational house, and so on.

To create a local food web involves investigating the local or regional constraints and opportunities. For the Hudson Farm project, a sustainable hedgerow street is part of the local food web since edible hedgerow was introduced in addition to the CSA operations (Fig. 17). The hedgerow street can also help to manage storm water, provide habitat for wildlife, and improve the micro-climate of the street and will contribute to the mitigation of climate change at regional scale (Fig. 18). The hedgerow neighborhood uses the proposed hedgerow as a main structure that provides guidance for orientation, traffic and a sense of identity of the neighborhood.

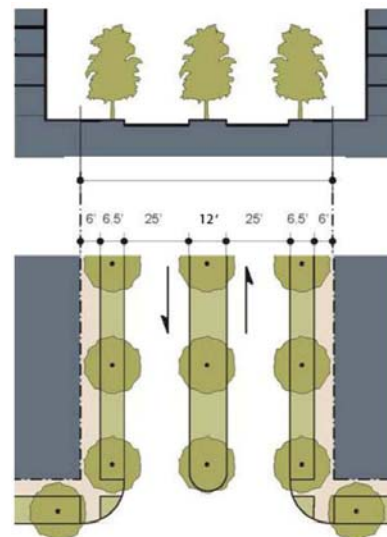


Fig. 17 Street dimensions based on the Hudson Farm Master Plan

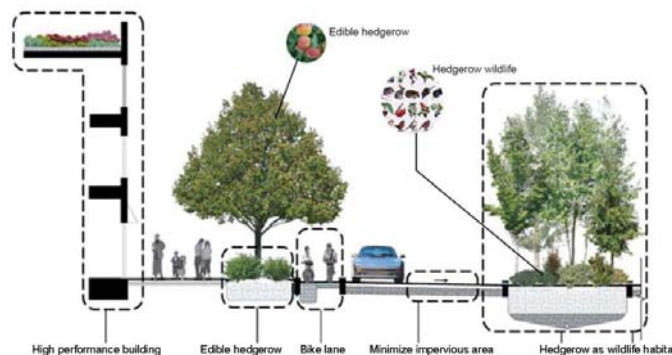


Fig. 18 Hedgerow street as part of the local food web and wildlife habitat

B. Visionary Framework for Sustainable Design

A sustainable community is able to minimize the input of energy and resources to its use, maximize reuse and recycle materials, and minimize the production of waste. Composting is efficient way to achieve these goals.

Composting. Considering the soil condition of Hudson Farm, a composting facility could benefit both the landfill (Fig. 19) in the City of Montgomery and also the local community by providing compost to rebuild the soil for CSA in the neighborhood or even a kitchen yard for individual household. The compost can also use other materials on the farm, for example, the fruit of Osage orange, which is very rich in carbon and nutrients, is an ideal material for composting.

Earthen Construction. Another opportunity for Hudson Farm is that the local soil is good for making earthen construction material, because of its clay nature. There are examples that use compressed earth blocks (CEB) as building material for residential houses in the south United States (Fig. 20; Fig. 21). For Hudson Farm project, the earthen construction material coupled with the composting idea would make this project an ideal model for sustainable design.

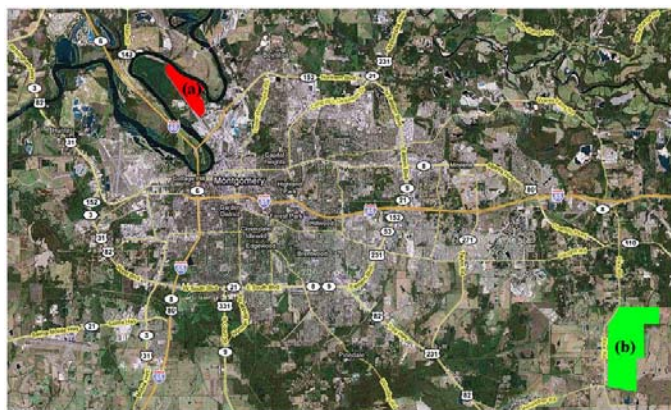


Fig. 19 Urban Context of the landfill of City of Montgomery and Hudson Farm. (a) Location of landfill site for the City of Montgomery; (b) Location of Hudson Farm



Fig. 20 Soil as construction material. (a) soil on Hudson Farm, (b) CEB machine making blocks; (c) a house under construction using CEB in New Mexico

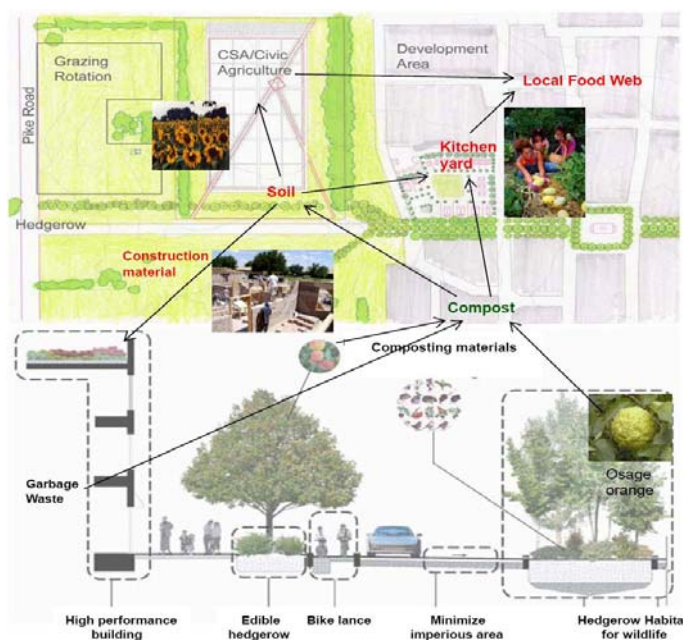


Fig. 21 Hudson Farm sustainable design framework integrating composting, earthen construction and local food web

The Framework for Sustainable Landscape Planning. Composting and earthen construction materials were integrated into the Hudson Farm development to make it a sustainable design. A sustainable design framework was provided based on the previous discussion about earthen construction and composting (Fig. 21). It begins with using the soil in the CSA area as construction material to build residential houses, where garbage and waste generated goes to composting. The abandoned fruits from the edible hedgerow, as well as the fruits of Osage orange trees, also go to composting. The composting product goes back to the CSA or individual household to support civic agriculture or kitchen yard vegetables, which are part of the local food web. This sustainable framework was based on the local condition of soil, vegetation, and government policy, as well as many other issues. It may or may not be useful for another project, but there are ways to consider sustainable design in every single project.

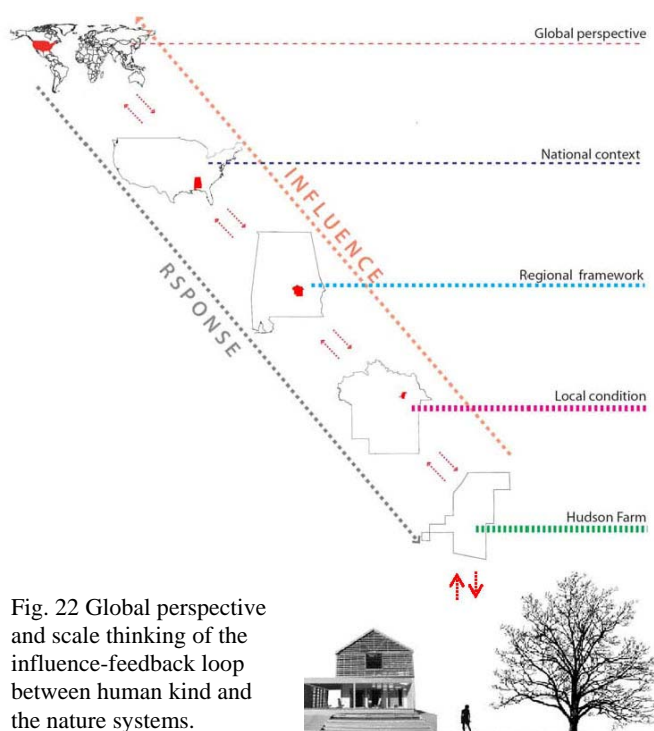


Fig. 22 Global perspective and scale thinking of the influence-feedback loop between human kind and the nature systems.

If we take a careful look at the influence-response loop between the human and the nature system, we will see across a range of scales every landscape we design, every house we build, every tree we grow, and every single person are within this loop, having a certain impact on it, and subject to its influence in every day life (Fig. 22). It is time that we need to rethink what sustainable design really means and what is the ecology of sustainable design, and to rethink our roles as architects and landscape architect in this period of history when human's societal well-beings are challenged by critical issues such as global climate change, environmental pollution, etc. Therefore, sustainability is a design issue. Sustainable design values a healthy relationship between man and the nature system.

V. CLOSING REMARKS

Sustainability is a design issue, and the sustainable design is the only possible successful way to the human settlement on this planet - our only home in the universe. Sustainable design should be considered in each landscape project, by each person who practices landscape architecture. Architecture design and landscape design will have to come together for a better future for humans. There is simply no other choice considering the future of our children and grand-children.

For the Hudson Farm project, the walkable neighborhood is sustainable, the multi-generational house is sustainable, to grow live-work space is sustainable, to develop climate-responsive architecture is sustainable, to create a local food web is sustainable, to maintain and protect biodiversity is sustainable, and the reforestation is sustainable. Hedgerows and other ecological infrastructure can be integrated into design and planning for sustainable development. Landscape planning, landscape urbanism and sustainable design should be united to design functional and ecological landscapes.

The meaning of sustainability is at least threefold: economically, ecologically, and culturally. This paper deals primarily with the ecological dimension of the issues of designing with hedgerow as ecological infrastructure. However, the cultural issues are equally important. In the hedgerow landscape, there is something peculiarly seductive about the idea that everyday features all around us can be a direct link with the deep past, and in the concept that history and ecology can combine to give – in a particular landscape feature – a distinct sense of place [27]. This study would be the foundation for further investigations focused on economic and cultural issues of similar land development projects, as long as they embody the very best principles and practices of sustainable urbanism to honor and integrate nature, ecology, local culture, and the built environment. In this sense, sustainability is a design and planning issue, which should be and could be a new direction for urbanism theory research in parallel to either green urbanism theory which is underpinned by a lot of practical greenway projects [28]-[29], or the emerging landscape urbanism theory [30]-[31] which has not been the guidance for any practical projects yet.

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