

STREET AFFORDANCES: HUMAN-ENVIRONMENT INTERACTION IN THE DESIGN PROCESS OF URBAN SPACE

AFFORDANCE DA RUA: INTERAÇÃO HOMEM-AMBIENTE NO PROCESSO DE PROJETO DO ESPAÇO URBANO

STREET AFFORDANCE: INTERACCIÓN PERSONA-ENTORNO EN EL PROCESO DE DISEÑO URBANO

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ABSTRACT

Incentives to walking as a transport mode are an integral part of the Brazilian National Policy on Urban Mobility, Federal Law 12.587/2012. Nonetheless, design approaches to streets are currently based on motorized transportation, which does not represent the necessary support to walking or to social, cultural, and leisure activities. During their evolution, streets reflected historical, economic, political, and social contexts influencing and being influenced by urban life. However, the advent of new technologies in traffic engineering, civil construction, and communication changed this scenario, and traffic systems started to lead the street design. Research on walking as a transport mode has shown the influence of street space on people's decisions to walk. Environment and Behavior Studies bring substantive knowledge of the human-environment interaction to the theory of Architecture and Urbanism. This knowledge is essential in the transition from designs based on normative theories to contemporary street designs. The Affordance Theory provides understanding of the transactional interaction of the person with the environment. To achieve the integral design of the street, we adapted the Affordance Based Design methodology. This procedural theory was seen as experimentally adequate both in the design process and in the evaluation for further adjustments in existing streets. The integration of a substantive theory and a procedural theory is essential to build spaces that give support to walking.

KEYWORDS

Street Design. Affordances. Walkability.

RESUMO

Os incentivos para a caminhada como modo de transporte são parte integral da Política Nacional Brasileira de Mobilidade Urbana, Lei Federal 12.587/2012. Apesar disso, as abordagens de design para as ruas são atualmente baseadas no transporte motorizado, o que não representa o apoio necessário para caminhar ou para atividades sociais, culturais ou de lazer. Durante sua evolução, as ruas refletiram contextos históricos, econômicos, políticos e sociais, influenciando e sendo influenciadas pela vida urbana. Contudo, o advento de novas tecnologias em engenharia de tráfego, construção civil e comunicação, mudou esse cenário e os sistemas de tráfego começaram a guiar o design das ruas. Pesquisas sobre caminhabilidade como modo de transporte tem mostrado a influência do espaço da rua na decisão das pessoas em caminhar. Estudos sobre ambiente e comportamento trazem um conhecimento robusto da interação homem-ambiente para a teoria da Arquitetura e Urbanismo. Este conhecimento é essencial na transição



de projetos baseados em teorias normativas para um projeto de rua contemporâneo. A Teoria da Affordance fornece uma compreensão da interação transacional da pessoa com o ambiente. Para alcançar o design integral da rua, adaptou-se, para esse artigo, a metodologia do Design Baseado em Affordance.

PALAVRAS-CHAVE

Design de rua; Recursos; Facilidade de locomoção.

RESUMEN

Los incentivos para caminar como modo de transporte forman parte integral de la Política Nacional de Movilidad Urbana de Brasil, la Ley Federal 12.587/2012. A pesar de ello, los enfoques de diseño de las calles se basan actualmente en el transporte motorizado, que no representa el apoyo necesario para caminar o para actividades sociales, culturales o de ocio. Durante su evolución, las calles han reflejado contextos históricos, económicos, políticos y sociales, influyendo y siendo influidas por la vida urbana. Sin embargo, la llegada de las nuevas tecnologías de ingeniería del tráfico, construcción y comunicación ha cambiado este escenario y los sistemas de tráfico han empezado a guiar el diseño de las calles. La investigación sobre la transitabilidad como modo de transporte ha demostrado la influencia del espacio de la calle en la decisión de las personas de caminar. Los estudios sobre medio ambiente y comportamiento aportan a la teoría de la Arquitectura y el Urbanismo un sólido conocimiento de la interacción entre el ser humano y su entorno.

PALABRAS CLAVE

Diseño de calles; Accesibilidad; Caminabilidad

1. INTRODUCTION

In 2012, the Brazilian Federal Government enacted the Brazilian National Policy on Urban Mobility, Federal Law 12,587, giving priority to non-motorized transportation modes in the development of urban mobility plans. However, in order to promote non-motorized mobility, the urban environment should support these transportation modes, which are performed mainly through the streets.

Environment and Behavior Studies provide design professionals with knowledge of the reciprocal relationship between the person performing the action and the environment in which the action takes place, considered as a transactional process. Thus, by understanding the relationship between the person who walks and the environment in which he or she walks, one can see the need for street environments that provide support to people during the course of the activity, resulting in the question "How can streets be designed in order to provide support for the activities taking place there?"

To answer this question, we will incorporate the Affordance Theory, developed by James J. Gibson (Gibson, 1986), into the street design process, combined with the Affordance Based Design methodology developed by Maier and Fadel for Product Design (Maier & Fadel, 2006). To explain the extent to which this approach is necessary, it is also important to understand the different scales and functions that the streets present.

Finally, we will outline the advantages that street designs based on affordances offer as an alternative to the street design approach commonly used in Brazil, which is based on the motor vehicles' traffic function.

2. STREET DESIGN

Streets promote integration of the urban space, enabling not only connection among different districts and neighborhoods but also access, on a smaller scale, by allowing the connection between the lots, such as home and work, school, shops etc. (Appleyard, 1981; Boaga, 1977; Childs, 2012; Ellis, 1981; Gutman, 1981; Jacobs, 1995; Schumacher, 1981). The organization of blocks includes dividing plots and guiding the configuration and size of the lots, limiting or allowing the growth of the city (Ellis, 1981). These physical spaces, which are simultaneously defined and structured by the streets, are able to create places in the urban context where human activities are conducted (Boaga, 1977).

At the macro scale, the streets are hardly separable from the road network to which they belong. Similarly, at the micro scale, there is such a dynamic interaction between built elements as facades, furniture, vegetation and non-built elements such as people's activities and social interactions, making it impossible to separate all the components that form them (Anderson, 1981; Childs, 2012; Rudofsky, 1982).

In addition to those functions, streets are also places where leisure, idleness, fun, manifestation and ceremonies can be carried out (Gutman, 1981). As the greatest public areas of the cities (Herce & Magrinyà, 2013), streets are where the neighbors meet (Appleyard, 1981), where, historically, many of the human activities occurred. Therefore, streets act as a joint between different physical and social scales of a city (Ellis, 1981). Thus, they must be treated as places not only as passageways (Jacobs, 1995; Kostof, 2004).

The streets' multitude of functions allow adaptation between isolated and concomitant uses relating such streets to different physical forms according to cultural, geographic, economic, political and social contexts, historical period and urban demands (Herce & Magrinyà, 2013). That said, the street per se does not have a standard form that should be reached to ensure its success, but it is the consequence of several variables present in the urban space, including the symbolic elements of the population. Good streets are those with which residents identify themselves and allow access for all people, inviting them to different activities, and appreciated by their users (Francis, 1991).

Nevertheless, despite all the roles that streets can play, the vehicular traffic function is generally dealt as the most important one. This thought is reflected in the design of these places, resulting in an urban environment that does not support extra activities other than motorized transportation. It is worth noting that the traffic function affects not only the carriageway but also the sidewalks, as they receive parking signs, parking meters, speed signs, traffic lights, as well as street lighting generally directed to the lane. Using this arrangement of elements, carriageways are free for drivers to use them, while sidewalks become a route full of obstacles (Macdonald, 2011) or end up as parking space (Figure 1).



Figure 1 – Car parking as a priority in the use of the sidewalk. Rua Vereador Arthur Mariano, municipality of São José, Brazil.
Source: Authors.

This concept of design based on a function to rule the configuration of the space is fragile as it disregards other important functions such as accommodation of urban infrastructures. It is noteworthy that, in Brazil, underground power supply and underground communication networks are rarely used. Hence, streets must also be sized to this need. It can be seen, in Figure 2, a cross section of a generic street, standardized by street hierarchy proposed in the Master Plan of the municipality of Biguaçu, Brazil. The street has 75% of its width dedicated to motorized transportation, regardless the size of the power poles, signs and curb. Besides that, land use and population density were also not consider.

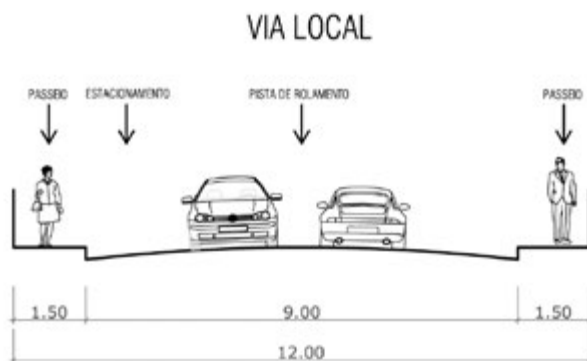


Figure 2 – Cross section of a standardized generic local street proposed in the Master Plan of Biguaçu, Brazil.
Source: Plano Diretor de Desenvolvimento Municipal de Biguaçu, 2007.

Another important issue concerning this design approach is the lack of dialogue between the different codes and standards that affect the design. According to Florianópolis' Building Code, butane plants must be detached from the building and located on the setback space.

However, as seen in Figure 3, there is no area for the butane supply truck, resulting in the use of the sidewalk as a load/unload area, which may cause damage to the pavement and manhole lids.



Figure 3 – Butane supply as one of the functions that streets should support. Rodovia João Paulo, Florianópolis.
Source: Authors.

This lack of relationship between the street design and the different elements and standards that compose the street's tridimensional space results in a defective environment, which is unable to meet the people's needs towards their activities. Recalling that streets are public environments for public use, they have to be designed for all people, and the integration of these elements is of great importance. For example, as can be seen in Figure 4, the full width of the sidewalk is 2,35m; however, considering the electricity pole position, its width drops to only 1,05m, narrower than what is required by the Brazilian Technical Standard 9050/2004 on accessibility.



Figure 4 – Sidewalk width of 2,35m resulting in only 1,05m of free space. Rodovia João Paulo, Florianópolis, Brazil.
Source: Authors.

Having said that, it should be understood that streets receive several functions besides motorized traffic, and all these functions must be thought together

in order to ensure that this urban space will perform its urban connection function, along with all other necessary functions for the development of the activities designed to a specific street.

Considering that the streetscape is a three-dimensional space formed by the all the parts that compose a street, and recognizing that this parts are inseparable from the whole (Anderson, 1981; Childs, 2012), the design of a street should be multidisciplinary, incorporating not only the technical requirements but mainly the requirements of the population because, as stated by Churchill (1962), "the city is the people."

3. AFFORDANCES

Environment Behavior Studies deal with subjects that relate the interaction among physical environment and human behavior (Churchman, 2003). By analyzing the person-environment interaction, these studies evidence that there is a reciprocal relationship between the person who carries out the activity and the place where the activity is done. Hence, environment and behavior cannot be seen separately, and environment has to be fully understood considering that the person is not a passive agent of this process, but acts on the environment and is influenced by it (Heimstra & McFarling, 1978; Ittelson, Proshansky Rivlin, & Winkel, 1974).

Based on this reciprocal relationship, James J. Gibson developed the Affordance Theory to explain the interaction between person and environment. He presents the concept of affordance as an opportunity of action that the environment or the object will offer to a person, but it depends on the person to perceive it. In other words, the environment will always afford opportunities of use, but it depends on the person's capabilities, limitations, personality, etc. to perceive them (Gaver, 1991).

One can understand the relationship between the perception of affordances and the street with the following example: a person who does not have disabilities does not see a broken sidewalk as an impediment to walk, but a person who needs a wheelchair to move around may notice this same sidewalk as an obstacle (Figure 5). Thus, the walking affordance that the sidewalk has is there, but the two people will perceive it differently.



Figure 5 – A sidewalk in poor condition is not perceived as an obstacle to walking by a person who has no disabilities, but for those who do, it can be an impediment.

Rodovia João Paulo, Florianópolis, Brazil.

Source: Authors.

Knowing that people are not passive to stimuli provided by the environment, it can be therefore understood that the presence of an affordance is not deterministic for an action to be performed. For example, a short wall has the affordance of sitting (Figure 6), but it does not necessarily mean that such action will occur just because the affordance is there (Figure 7). The presence of an affordance is not deterministic for an action to occur, but the environment is deterministic for an action not to occur. In other words, if the environment does not provide support for a certain activity, this activity cannot be performed (Rapoport, 1990).

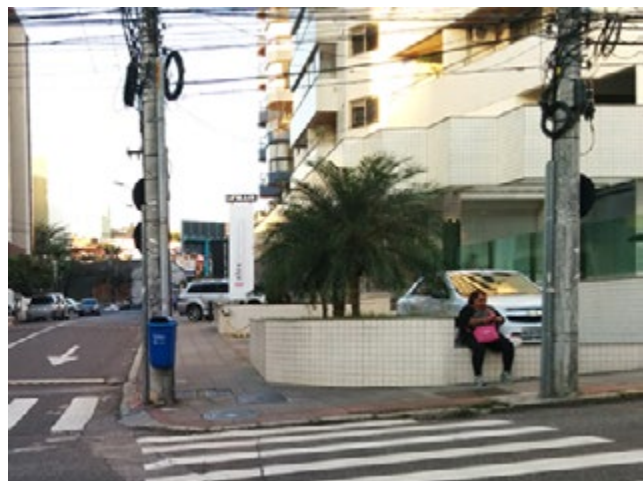


Figure 6 – One can perceive the affordance and perform the action. Therefore, this person perceived the affordance of sitting provided by the wall.

Source: Authors.



Figure 7 –The affordance of sitting may be present, but people do not necessarily use it.
Source: Authors.

“The composition of the built environment affords a variety of things to the potential user. It affords visual stimulation and haptic stimulation; it might also provide sonic stimulation and olfactory stimulation. [...] In addition to stimulation as such, the built environment affords many other things that support some behaviors and restrict others. The list is almost endless. [...] The affordances of a particular pattern of the built environment are a property of its layout, of the materials of which it is fabricated, and of the way it is illuminated – with reference, always, to a particular set of people” (Lang, 1987, p. 83).

Knowing that the environment offers opportunities of use for those who will perform the action is important for the urban space design as it allows recognizing that the design process always involves creation, modification or elimination of these opportunities of use, i.e., affordances. With that in mind, it should be understood that affordances can be positive and/or negative (Gibson, 1986). The same sharp blade that affords to cut steak for an adult, a positive affordance, also provides the negative affordance of injuring yourself. In the urban space, such relationship is established as follows: the same carriageway that affords high speed for drivers has a negative affordance of being unsafe for a person to cross from one side to another. Therefore, one can understand that the manipulation of the environment can bring positive and/or negative opportunities of use to different activities in a particular context.

Besides being positive and/or negative, affordances also have the property of multiplicity, which refers to the multiple affordances that the same environment or

object can offer (Gibson, 1986). Going back to the short wall example, it prevents the passage but can also afford sitting, support objects on its surface, etc.

As the perception of affordances is related to who carries out the action, it is necessary that the design process incorporate not only technical requirements, but it must also be grounded in joint effort among technicians and community. Although citizen participation is often questioned or poorly conducted in Brazil, its importance needs to be highlighted as it brings substantive knowledge to the scientific and procedural spheres, that is, how the world is; unlike the usual approaches to street design, which are based on normative knowledge that says how things should be (Murphy, 2005). This difference may sound superficial, but it is fundamental in the design of micro and macro scales since the normative theory represents idealized knowledge based on habits and beliefs of those who design (Moudon, 2000), generating inconsistencies in how people live, as pointed out by Hershberger (1974, p 148.):

“Will the architect’s knowledge of and empathy for [...] the occupants of those buildings allow him to make consistently accurate predictions about responses to what he designs? [...] In the absence of better information, however, this is what the architect tries to do. Sometimes he succeeds. Quite often he fails. And failure is not a trivial matter.”

An example of the difference between designers’ and communities’ perceptions can be seen in the social housing project Pruitt-Igoe in St. Louis, USA. Due to the lack of knowledge on how people lived, their habits, needs and culture, the architects in charge of that project based the design on how they thought the future residents lived and how they thought they would like to live. Therefore, these architects designed wide corridors to lead the residents to the apartments and also to be used as a social area. For the designers, the wide corridor would afford support to social activities. This affordance was not perceptible to residents, but these same wide corridors offered perceptible affordances to some residents such as drug dealing, vandalism and theft, resulting in the demolition of more than two thousand housing units twenty years after the end of the construction (Lang, 1987).

Considering that the design of a built environment consists in manipulating affordances and that the perception of these affordances depends on the person who carries out the action, it is necessary to turn this process

into a conscious process by improving the positive affordances and mitigating the negative ones that the environment may offer to the people.

4. APPLYING THE AFFORDANCE THEORY TO STREET DESIGN

By analyzing a street design based on traffic function, one can see that all its affordances are conceived for the use of motorized transportation. In that sense, for example, carriageway resurfacing affords higher speeds, large curvature radius in the corners affords drivers to turn with little deceleration, parking space affords people to leave the car somewhere while it is not used, and so on. However, as affordances have the properties of multiplicity and polarity, it is important to recognize that the carriageway resurfacing affords those traveling by a vehicle the opportunity to speed up, while it affords pedestrians difficulty to cross the street.

Understanding that objects and environments provide affordances to the person who will use it contributed to the development of the Affordance Based Design, an affordance-based procedural theory for Product Design developed by Maier and Fadel (Maier & Fadel, 2006). These authors recognize that, while interacting with an object or environment, the person is interacting with the whole system that composes this object. A room, for example, affords shelter; however, in order for the room to afford shelter, the foundations must support the weight of the building, the structural system will support the floor, roof and walls, and walls will support the openings (Maier, Fadel, & Battisto, 2009). Thus, the person perceives the affordance generated by the whole system that composes the environment.

A blender, for example, affords grinding the food, but the grinding affordance depends on when a person presses the button to turn on the motor and the motor rotates the blade inside the cup. Therefore, the Affordance Based Design considers not only the affordances directly related to the person's interactions with the object, but also the indirect relations that make the system provide the affordance (Maier & Fadel, 2006).

These interactions among the elements that compose the object or environment are named by Maier and Fadel as Artifact-Artifact Affordances (AAA), and the opportunities of use that the object or the environment affords people are the Artifact-User Affordances (AUA). It is noteworthy that in both cases these affordances can be positive

or negative.

On the streets, this AAA interaction can be observed with the following example: the curb leads rainwater to the drain grates which will lead the rainwater to the underground urban drainage system. The curb affords the streets not to get flooded when it rains (AAA positive). If the street does not have a rainwater drainage system, it may get flooded, causing damage to the asphalt and sidewalks, erosion of the buildings' foundation, preventing people from developing their activities there (AAA negative).

In the same manner, regarding the choice of the elements that shall compose the space, it is necessary to consider how each element may interfere with the functioning of the street as a whole. Comparing the two drain grate models shown in Figure 8 and Figure 9, it can be seen that the first one presents positive affordance relative to rainwater collection (+AAA) at the same time that it presents negative affordance for trapping bicycle wheels (-AUA). The second model presents positive affordance in terms of water collection (+AAA); however it does not show a negative affordance as the previous model did.



Figure 8 – Drain grate model showing positive affordance for rainwater collection but negative affordance for trapping bicycle wheels. Rua Altamiro Barcelos Dutra, Florianópolis, Brazil
Source: Authors.



Figure 9 – Drain grate model showing positive affordance for rainwater collection but no negative affordance for trapping bicycle wheels. Rua Altamiro Barcelos Dutra, Florianópolis, Brazil
Source: Authors.

Therefore, the design of an environment involves creation, modification or elimination of what the environment will afford. Thereby, looking back at the street design approach based on motorized traffic functions in Figure 10, one can see that this interaction with the systems has not been addressed. Consequences of the use of this design approach can be seen in Figure 8. There is not enough room on the sidewalk to place the electricity pole. In addition, manhole lids are placed over the tactile directional floor, and one of these lids is in front of the driveway gate of the building and may break under the weight of the vehicle, which may interrupt passage and cause a distracted or visually impaired person to fall down.



Figure 10 – Interactions between the systems that compose the street must be planned jointly so that the environment can support the different activities assigned to it. Rua Frei Hilário, São José, Brazil.
Source: Authors.

The design of a street has to be different according to land use and population density, as it will impact the

street usage in different ways. As much as zoning is the same along a street, the same commercial zone can receive different types of businesses. A stationery shop and a grocery store feature various demands in the street space. The grocery store, for example, receives supplies daily in order to have fresh food, but it also has a high product turnover. Thus, the need to load and unload is greater in a grocery shop than in a business that does not have this need of replacing products so often. If the street does not support the needs presented by the use of the buildings, the supply of products either may not be provided or interfere in the performance of other activities, as can be seen in Figure 11.



Figure 11 – Lack of load/unload area interferes in other activities in the street. Rua João Piu Duarte Silva, Florianópolis, Brazil.
Source: Authors.

As affordances have the property of multiplicity, the same element can afford support to different activities and, in the same way, different elements may provide the same affordance. Traffic calming measures can be implemented with different strategies, such as horizontally or vertically deflecting the carriageway, narrowing the road, paving, among others. Thus, this approach allows greater freedom to the design, since the same element can respond to various requests and the same request may be fulfilled in different ways.

Therefore, one can understand that the street is a complex environment housing different functions at the macro and micro scale, being generated by the interaction of all the elements that compose it, and this interaction should result in a design that meets the population's needs. As previously discussed, the perception of affordances is relative to the people who will use the place, therefore the affordance based design must rely, first, on knowing the community's needs, having in mind that, as

the street is a public space, it must provide opportunity of use to all people, regardless of their abilities or limitations.

Lastly, it is important to consider that it is not possible to eliminate all negative affordances because at the same time that the carriageway affords risk of injury to pedestrians, it also affords the possibility to travel around the city. Thereby, the designer's role is to control the entire system's relationships that compose the environment in order to strengthen positive affordances and try to eliminate, where possible, negative affordances.

5. CONCLUSION

The street design should consider the role that streets play in the urban scale and in the human scale, considering the different contexts and functions that will simultaneously occur. Two different streets in the same city can have the same design but one may work differently from the other, owing to topography, zoning, culture, economy, among others.

The incorporation of knowledge from different fields helps understand that the environment, as a whole, will provide people with opportunities of use, and these opportunities will be perceived differently according to the user. Therefore, the design should respond to the requests of each context and be grounded in the knowledge that the community will provide

The integration of the Affordance Theory in the street design presents itself as a manner of conceiving the urban space, incorporating people's perception and the elements that, together, create this place. This approach enables the design to not only be based on technical opinion, but also consider citizens' participation necessary to create an environment that provides different opportunities of use, rather than focusing on a single function.

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ADN: conceptualization, formal analysis, methodology, project management, supervision, visualization, writing - original draft..

FGO: conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing - review & editing.

Conflict declaration: nothing has been declared.