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WHAT IS THE EXPLANATORY POWER OF SPACE SYNTAX THEORY?

The application of modal logics from theory of science

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ABSTRACT

This contribution shows various approaches from the theory of science for revealing the explanatory power of the Space Syntax. In this contribution Bhaskar's critical realistic model of science and Georg Henrik von Wright's account of *explanation* and *understanding* are used to assess the explanatory power of Space Syntax research. In essence subsequent considerations distinguishes between a theory able to offer an *explanation* of phenomena and a theory proposing an *understanding* thereof. It will lead to the conclusion that the theory of the natural movement effect can offer an explanation of changes in a built environment in terms of cause and effect, while research related to social rationality, archaeology or historical research, space and crime or anti-social behavior, cognitive aspects aims at an understanding of the culture or meaning associated with the causes at issue. Moreover, research concerning how activities in society affects urban space requires a hermeneutic approach, whereas research concerning how a spatial layout can affect activities in society requires both a positivistic as well as a hermeneutic approach. Seemingly, human behaviour as an effect on spatial structure depends on the type of rationality of human intentions and behaviour the research is focusing on. Marked rationality can use positivistic explanation models, whereas other kinds of rationality rely on hermeneutic ones.

KEYWORDS

Theory building, modal logics, positivism, hermeneutics, explanations, Space Syntax theory

1. INTRODUCTION

In what ways are theories on built environments able to explain certain kinds of urban changes? Are they able to predict future effects of recent urban changes? Or are they confined to offering an understanding of according phenomena? At present the challenge for Space Syntax is to make proper theories (Hillier 2013). Whereas Hillier approaches theory building on Space Syntax from a social anthropology angle (Hillier 2016), other authors approach it from an urban sociology perspective (Marcus 2015, Koch 2015, Griffith 2015). Hillier's main question is what are cities for? His answer is to create contact. Therefor the challenge is to *explain* or to *understand* the spatial factors shaping opportunities for creating contact.

Building systematic theories on built environment is still in a beginning phase. The reason is that most writings on built environment tend to have a *normative* approach (Hillier and Hanson 1984, p. 5), where the authors describe *how* to make a good city. What is lacking is a description on what a good city is or how a city *function* spatially and in relation to society. Conversely, writings in the field of urban sociology lack concise definitions of space or understandings on the physical framework on where various social interactions take place. During the last two decades, computer developments have made it possible to work with large amount of big

data and with whole regions. Several empirical based research projects are carried out the last decade.

If a discipline is lacking a theory or the theory is not proper developed, then one starting point could be from the elementary theory of science. My contribution is to approach theory building on built environments through the use of Georg Henrik von Wright's modal logics combined with Roy Bhaskar's models on how research can be described on "think", "see" and "is" levels.

Any explanation of urban changes requires identifying their causes. For this purpose it is necessary to identify intended and unintended effects of proposed plans, to describe in detail how cities actually are built up and work, i.e. how they function, and finally what their different elements mean. Research on the setup of built environments depends on answers to these questions.

The first part of this article will present different ways of perceiving reality in a scientific perspective. For this purpose it is useful to turn to Bhaskar's critically realistic model of science first. In this article's second part, the explanatory power of the theory of the natural movement economic process and the theory of the natural urban transformation are revealed. Likewise, the explanatory power of space syntax research related to socio, historical or cultural issues will be revealed. As will turn out various research approaches with the application of Space Syntax use different models of casual explanation. Finally, a discussion of limitations and challenges of theory building in Space Syntax will be appropriate.

2. THE CRITICAL REALISTIC VIEWPOINT

As any research investigations on the built environment presupposes a general account of the ways one *perceives* and *thinks* of reality and what it actually is. Bhaskar distinguishes three levels research has to account for. The first level is labelled the "is" level, concerning reality in so far as one intends to know about it, to understand it, and to predict its further course. The second level is the "see" level, dealing with the perception and observation of reality. But likewise the application of scientific theories to gather accurate information about reality is at issue. The third level is the "think" level, comprising notions, ideas and thoughts about reality. Fig. 1 presents basic interdependences between these three levels (Troye, 1994, p. 33). According to
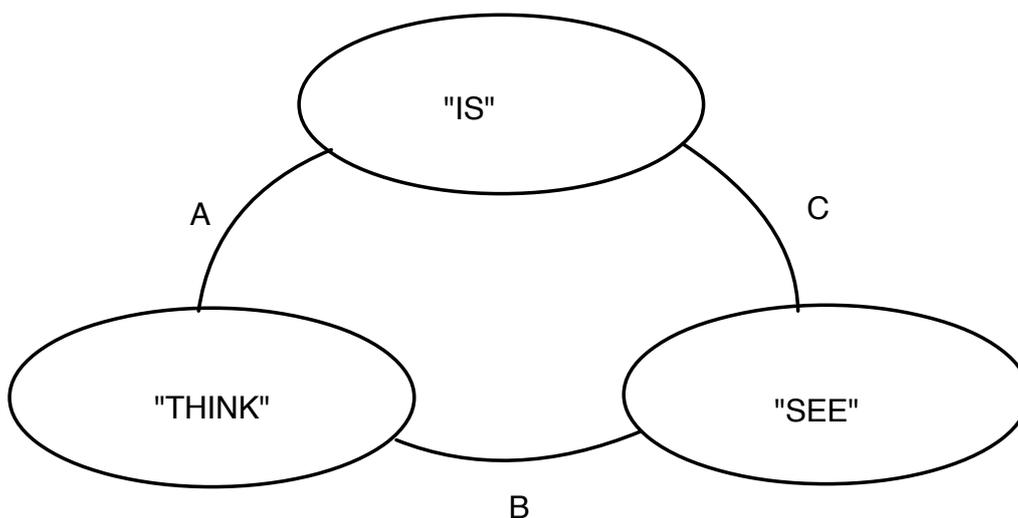

Figure 1 - Three levels for describing research

Bhaskar, these three levels are interrelated with one another in four different ways. He proposes the following four epistemological attitudes based on the above-mentioned three levels:

Rationalism: The researcher as thinker

Idealism: The researcher as inventor and creator

Empiricism: The researcher as observer and discoverer

Realism and critical realism: The researcher as critical thinker, inventor, and discoverer

Rationalism obviously favours thought. Here research sets out from concepts of the built environment, its structures and order. In this perspective reality is a conceptual issue. Observation receives little attention. The canonic example of rationalism is Cartesian philosophy, often labelled by Descartes' thesis "Cogito ergo sum" (Troye, 1994, p. 34). The thick line *A* in figure 2 from the "think" to the "is" level is meant to indicate this stance.

An idealistic view implies that the idea one has about a phenomenon is part of reality. In Hegel's idealism for instance, reality gets transformed in terms of speculative ideas about it. The ideas one has e.g. about elements of a built environment are a forming part of it. In an idealistic sense the acknowledgement of truth does not just result from observation, but is also due to the scientist's grasp and vision of reality (Troye, 1994, p. 36-46). The thick lines *B* and *C* in figure 2 from the "think" to the "see" and further to the "is" level illustrate this stance.

A rationalistic perspective

An idealistic perspective
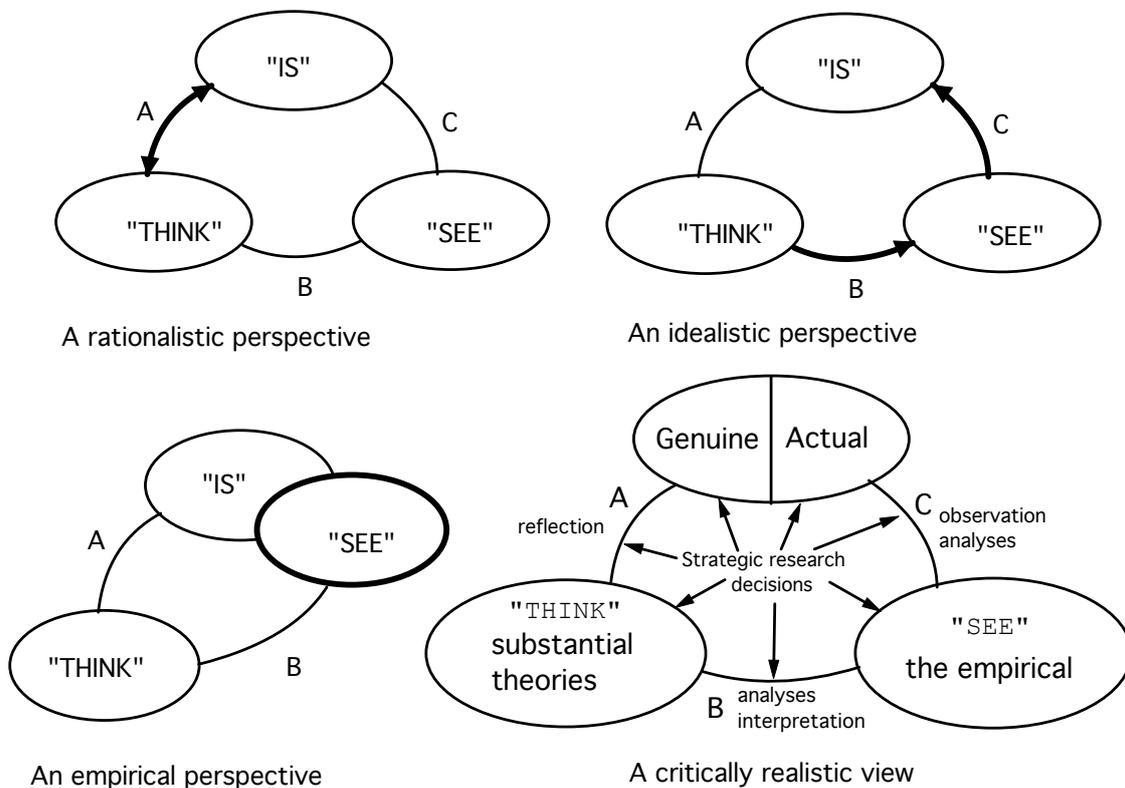
An empirical perspective

A critically realistic view

Figure 2 - Various types of perspectives

An empiricist epistemology mostly presupposes that reality is conceived in terms of the observer's perceptions. While reality is not in a sense directly accessible for the rationalist or the idealist, truth in the empiricist sense finally results from the perceptual data the observer manages to receive (Troye, 1994, p. 46-55). As shown in figure 2, this stance is illustrated by conflating the "see" and "is" levels.

Realism and critical realism include aspects of all the three above-mentioned models with the purpose to account for the development of scientific theories. This stance implies that theory development has both rationalistic and idealistic stages, where searching for empirical support. Reality, as presented on the "is" level, is divided into two parts: a genuine and an actual one. The genuine part consists of structures and systems that cannot be seen, while the actual one consists in ways in which reality presents it-self in observation and experience.

In comparison with the three other models of a basic epistemological stance, the critically realistic model has a major advantage. It is sufficiently comprehensive to account for the internal development of scientific theories and according research. How to use this model to acknowledge theories as being appropriate for research on built environments?

Various Space Syntax research fit into Bhaskar's critically realistic model. However, this model scarcely allows for an assessment of a theory's explanatory power. But associating von Wright's concepts of explanation and understanding with Bhaskar's critically realistic model, allows discussing the explanatory value of various types of Space Syntax research. As will turn out, it is their difference in explanatory power that requires acknowledging them as belonging to different scientific traditions. In this contribution the explanatory power of the different kinds of statements need to be set forth. As it turns out, Space Syntax is able to explain changes in urban space and changes in flow of movement and economic related activities and to understand cultures, human behaviour and cognitive factors related to urban space.

3. THE EXPLANATORY POWER OF STATEMENTS

From the theory of science, Carl Gustav Hempel's classical deductive-nomological explanation model is set up as follows (von Wright, 1971, p. 10):

Explanandum: The phenomena or facts that have to be explained

Explanans: The conditions affecting the phenomena or facts to be explained, and the general laws and explanation principles

Explicatum: The explained phenomena or facts

This explanation model does not mention any concepts of cause and effect (von Wright, 1971, p. 15). However, von Wright has clarified the notion of casual explanations in a way sufficiently clear for the present purposes. Casual explanation models are dependent on two epistemological traditions of scientific methods, namely the positivist and the hermeneutic tradition. Both these scientific traditions impose different structures and conditions on their causal explanation models. The way these models are built up depends on how according theories are set up, and on the way they are able to use these models to explain particular phenomena (von Wright, 1971, p. 1-4).

The positivist tradition emphasises the identification of the causes of certain phenomena. Due to this methodological option according theories account for the effects of causes with a high degree of *predictability*. Their explanatory models anticipate nothing but the effect of certain kinds of causes (von Wright, 1971, p. 3). The hermeneutic tradition emphasises explanations that search for an *understanding* beyond the phenomena. They aim at intentions implicit in the explanandum part of Hempel's model (von Wright, 1971, p. 4).

Von Wright bases his causal explanation models upon the concept of a precondition he prefers to the notion of a functional condition. Obviously, he distinguishes between *necessary* and *sufficient* conditions. The usage of these kinds of conditions regulates as to whether the causal explanation model is applied to a hermeneutic or a positivist form of research (von Wright, 1971, p. 38). As regards terminology von Wright calls causal explanations in a positivist perspective simply *explanations* while in the hermeneutic case they are labelled *understandings*. In the first case an explanation relates to sufficient conditions accounting for the causes of certain effects. In the second case understanding results from an assessment of necessary conditions reasonably associated with causes.

Causes precede their effects. The notion of time is a decisive, thought certainly not sufficient criterion for the distinction between causes and effects (von Wright, 1971, p. 41). Von Wright's proposed models of scientific explanation and understanding comply with Bhaskar's critically realistic model. As shown in figure 4, Troye draws a model of different explanation levels based on Bhaskar's critically realistic model (Troye, 1994, p. 132).
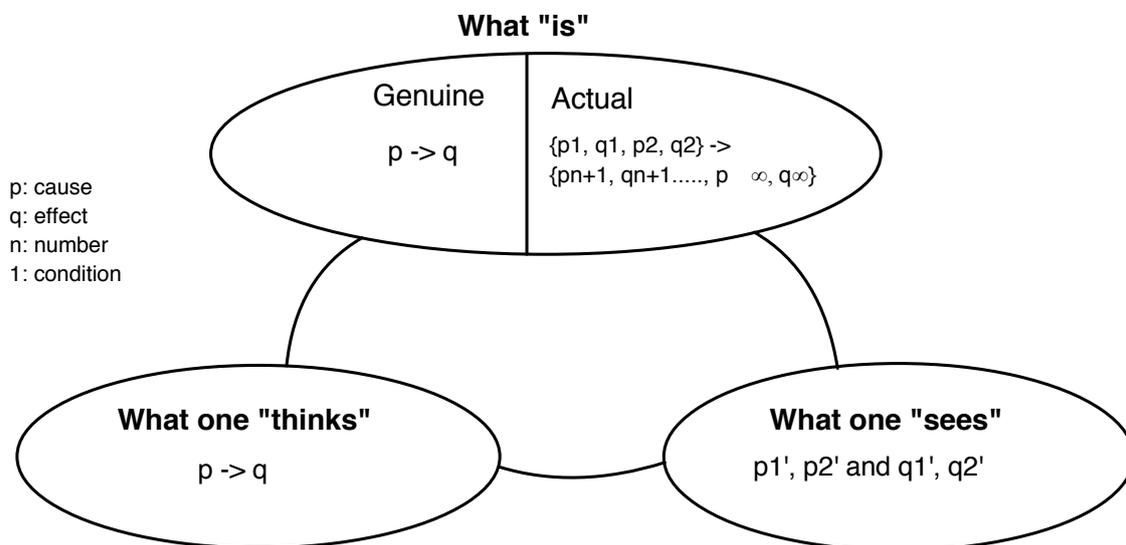

Figure 3 - Troye's explanation model based on Bhaskar's model

Consider a cause in figure 3 to be *p* and an effect to be *q*. One can conceive of their relationship both on the "think" level and in the genuine part of the "is" level. What one perceives is each separate cause *p1*, *p2* etc. together with each matching effect *q1, q2* etc. on the "see" level. But one does not experience the relationship between them. But experiments and their theoretical presuppositions and reflection make it possible to gain knowledge about the relationship between p and q presenting themselves in the actual part of the "is" level. On this level each particular state can be observed. One perceives each separate cause *p1* and *p2* with their matching effects *q1* and *q2*. By adding an invisible condition, labelled +1 in figure 4 some presumptions about the effect *qn* from a future cause *pn* can be made. This presumption of future cause and effect is made on the basis of observations of existing cause and effects.

The model in figure 3 is appropriate for explanations belonging to the positivist tradition. Research belonging to the hermeneutic tradition though would be represented inadequately in this model. However, integrating von Wright's model of understanding into Bhaskar's critically realistic model can adequately assess the explanatory power of research from the hermeneutic tradition.

4. RESEARCH CONCERNING SPACE, HUMAN MOVEMENT AND MARKED RATIONALITY

Space Syntax research complies with the positivist tradition in epistemology when only focusing on analysing spatial changes as an effect of physical interventions. While research in the Urban Morphology and place Phenomenology tradition is closely intertwined with human intentions and attached meanings behind the artefacts, the former variety of research seeks to explain how a city is set up as an object, irrespective of human precondition of causation. For this purpose a built environment is conceived as a set of spaces shaping a configurative spatial system. Each physical change in the built environment affects its configurative spatial system.

Research and theory building on built environments becomes more complex when dealing with intentions behind human behaviour. However, Space Syntax researchers have managed to develop a theory on the relationship between spatial configuration, human movement and the location of economic activities.

As Thomas Markus stated in his keynote presentation at the 5th international space syntax symposium in 2005, the theory of the natural movement economic process is acknowledged so far to be one of the best developed theories on built environments. When dealing with human rationality where the intentions are unambiguous, it is possible to predict human behaviour effect caused by spatial changes. Marked rationality and all kinds of rationality dealing with time-efficiency has unambiguous intentions, which makes explanations and theory building possible in line with the positivistic research tradition.

Causal explanation models seem appropriate to assess the explanatory power of Space Syntax. Trivially enough, causes occur before their effects. In the first instance it is thus appropriate to identify the causes of events to be explained. In the main Space Syntax accounts for urban changes as changes in a spatial configurative system.

Human movement in and human occupation of spaces articulate functional aspects of the way spaces are used. Space syntax research searches for causal explanations of changes in a built environment considered as an object and how these changes affect human activities in society in terms of functional changes.

Again, examples referring to the relationship between road building and urban changes will be used. Under the presupposition of Hempel's classical deductive-nomological model, explanations related to marked rationality seem to be more substantial and general than those offered by social rationality:

Explanandum (effect): A newly constructed road changes the flow of human movement and location pattern of shops in a city.

Explanans: The theory of the natural movement economic process: The spatial configuration of a built environment influence human movement and the location pattern of shops.

Explicatum (cause): A newly constructed road changes the configurative system of a city. This change influences the movement routes for travelling from everywhere to everywhere else, and likewise the location pattern of shops.

Hempel's explanation model is a basic achievement of positivist epistemology, but it does not present the linkage between cause and effect in as perspicuous a manner as von Wright's causal explanation models. Space Syntax research seeks to find explanations for the interdependence between physical form and some kinds of human behaviour patterns. As regards von Wright's account of explanation, these preconditions allow for the following instantiation of a general explanation model as regards cause and effect:

Effect (consequences): The spatial configuration of an urban street network is changed.

Cause (reasons): A new movement route has been established.

This causal model is solid as regards general phenomena as well as context dependent cases.

Effect (consequences): The integration value of Bull Ring Square in Birmingham has decreased between 1985 and 2000.

Cause (reasons): A new ring road changed the configuration system of the street network in Birmingham centre. The ring road cut off the street leading to Bull Ring Square from the city centre.

The examples above show how Space Syntax research has explanatory power when dealing only with the physical aspects of the built environment. When adding unambiguous intentions, it works well for both general cases as well as context dependent cases:

Effect (consequences): Shops has disappeared from Bull Ring Square from 1985 to 2000.

Cause (reasons): Birmingham's inner ring road changed the configuration system of the street grid in its centre. This ring road dragged all the integration values away from the town centre's streets.

Effect (consequences): The location pattern of shops has changed.

Cause (reasons): A new ring road contributed to change the dispersal of integration values of the street network.

In general the development of scientific theories aims at an increasing degree of generality. Hence, only general examples are presented in terms of von Wright's explanation models for research related to marked rationality.

4.1 SUFFICIENT AND NECESSARY CONDITIONS

As regards necessary and sufficient conditions in von Wright's explanation models, is a new movement route a necessary or sufficient condition for changing the spatial configuration system in an urban area?

Von Wright: p is a sufficient condition of q.

Space Syntax: A new road link is a sufficient condition for a change in the spatial configuration system.

Von Wright: *p* is a necessary condition of *q*.

Space Syntax: A new road link is a necessary condition for a change in the spatial configuration system.

An essentially positivist explanation model requires sufficient conditions for explaining the relationship between cause and effect. The explanatory power of Space Syntax thus cannot consist in anything more than means to identify the conditions necessary for the occurrence of phenomena of a specified sort. A new road link effectively brings about changes in a given spatial configuration system. Other aspects too can result in configurable spatial changes. However, it is sufficient that only one of them comes into being for bringing about changes in a city's spatial configuration system. In essence Space Syntax sets out conditions sufficient for a change in a built environment. A complex sufficient condition consists in a conjunction of phenomena (von Wright, 1971, p. 39). Again von Wright's schematic description is paralleled with an example from Space Syntax:

Von Wright: Maybe p or r alone is sufficient for that q will occur. But if p and r occur together, q is sure to be there too.

Space Syntax: Maybe a new road link or a road blockage alone is sufficient for that spatial configurable change will occur. But if a new road link and a road blockage occur together, spatial configurable change is sure to be there too.

In a complex necessary condition p and r are logically separated from one another. While a complex sufficient condition consists in a conjunction of a phenomenon, a complex necessary condition presents itself as a disjunction. The subsequent example shows how Space Syntax accounts for complex necessary conditions:

Von Wright: Maybe r does not require the presence of p (unconditionally), nor the presence of q (unconditionally); but r may nevertheless require that at least one of the two, p or q, be present.

Space Syntax: Maybe spatial configurable change does not require the presence of a new road link (unconditionally), nor the presence of a road blockage (unconditionally); but spatial configurable change may nevertheless require that at least one of the two, a new road link or a road blockage, be present.

In a more refined perspective von Wright introduces explanation models as to why something was or became necessary, or, conversely, why something was or became possible. In the "why necessary" type of explanations, sufficient conditions are crucial, and in the "why possible" type,

necessary conditions are crucial (von Wright, 1971, p. 58). Below both explanations models are presented with reference to an application of Space Syntax.

Why something became necessary: A new road link is one of the sufficient conditions for spatial configurable change.

Why something became possible: A new road link is one of the necessary conditions for spatial configurable change.

Here the second example appears to be inadequate. In essence, Space Syntax focuses on the sufficient conditions of changes in urban space.

4.2 ACTIVE AND PASSIVE EXPLANATIONS

Von Wright refines his account of explanation by distinguishing between active and passive explanations. In the second case one search for regularities in a system's development by observations that do not initiate the process under concern. In the first case the initial state of the observed process is produced at will (von Wright, 1971, p. 82).

Space Syntax relies on both active and passive explanations. It is thus possible to observe how movement and occupation occur and compare the results with the spatial configurative analyses as well to block movement routes and observe how a movement pattern will change.

During the last two decades, technological development made possible to test out how people orientate and move through a virtual environment created through computer simulations. With 3D glasses, people are able to move in a lab through these virtually created environments making possible to test how people behave in for example empty or crowded urban areas. In her PhD thesis Spatial Navigation in Immersive Virtual Environment Ruth Conroy carried out experiments concerning the way people choose routes at road junctions in a virtual environment [Conroy Dalton, 2001, p. 47]. Her research illustrates in what way Space Syntax research aims at active explanations.

4.3 COUNTERFACTUALS

Counterfactual considerations are another means to consider the relationship between cause and effect. It is useful to set out what happens if a prediction is not verified.

Space Syntax: If a new road link were not constructed, no change in the spatial configuration system of an urban area would occur.

Conditionals of this form are truly relevant. No spatial change in an urban grid implies no configurational changes. The example shows that Space Syntax research has high degree of predictability.

4.4 EXPLAINING CAUSE AND EFFECT

Space Syntax is designed to set forth research on the built environment as an object purely in terms of cause and effect. It accounts for predictability, where Space Syntax research is set up to predict effects of urban physical spatial changes.

The ascription of meaning or intentions is scarcely relevant in Space Syntax' spatial part. It therefore may be applied independently of any particular human culture. It relates to the built environment as an object as such, irrespective of preconditions such as human intentions and meaning. Hence, and with explicit reference to Bhaskar's critically realist model, explanations in terms of Space Syntax present themselves as shown in figure 4:

The "think" level and the genuine part of the "is" level in figure 4 represent an explanation in terms of cause and effect; e.g. a new road link causing a configurational change of the urban street grid. These two levels represent the changes in non-discursive relationships. Here changes in the integration values of a city's street grid are at issue.

On the "see" level both effects and causes are identified by according representations by maps or models of an entire built environment in a before and after situation. It is possible to perceive each new road link, and the location of functions. An overview of an entire built environment's dispersal of function and street grid is represented on maps or models.

In the actual part of the "is" level one can derive from a set of causes, here several new road links, and their matching effects, thus functional changes, how future new road links will affect the dispersal of functions. The spatial configurative changes are represented as non-discursive relationships, which can explain the relationship between a new road link and changes of space use.
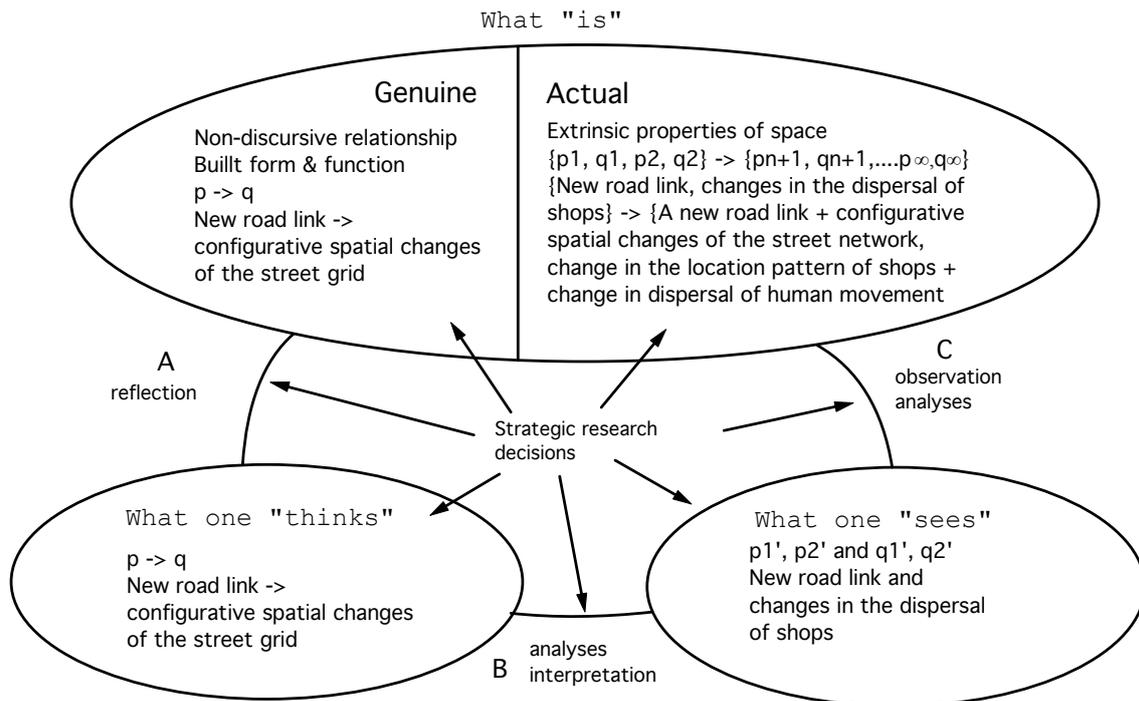

Figure 4 - Space Syntax' explanatory power according to Bhaskar's model

The way in which a comparison between the results of calculations and registrations of changes in space use is visualised in maps or other kinds of diagrams allows perceiving how a new road link changes urban areas. The use of maps and models thus demonstrates how Space Syntax sets out that a new movement route affects urban areas.

Explain the effects of a new road link on urban areas, one registers first the functional changes in a built environment on the "see" level. Moreover, an assumption on that a new road link causes configurational spatial changes in the street grid is made both on the "think" level and in the genuine part of the "is" level. This hypothesis can be strengthened by empirical research recording changes of functions and movement through a street grid and also by calculating the relevant changes in a before and after situation on the "see" level. In the actual part of the "is" level one thus discovers how a new road link affects the functions in an according built environment. In order to identify in all detail a before and after situation of a new road, it is necessary to use maps for seeing how a new road change the dispersal of functions in urban areas.

The explanation represented above pertains only to the built environment as an object. Calculating configurative spatial relationships allows comparing built environments from different cultures. The spatial product created from different cultures can be calculated and compared. Research has shown that Arabic cities have a more segregated structure than

European ones (Hillier, 2001, p. 02.9) and (Karimi, 1998, p. 269-284). However, Space Syntax is not able to make general statements in which various cultures put influence on an urban grid's structure. Research of this kind belongs to a hermeneutic tradition, and has to consider already established urban areas influenced by various cultures. What all cultures have in common are economic activities. Therefore it is possible to make general statements on how activities of this kind react to spatial configurative changes. The theory of the natural movement economic process (Hillier et al 1993) and the theory of the natural urban transformation process (Ye and van Nes, 2014) states that the spatial configuration of the street and road network influence the flow of movement through urban areas, building density, property prices, degree of multi-functionality, and the location pattern of shops.

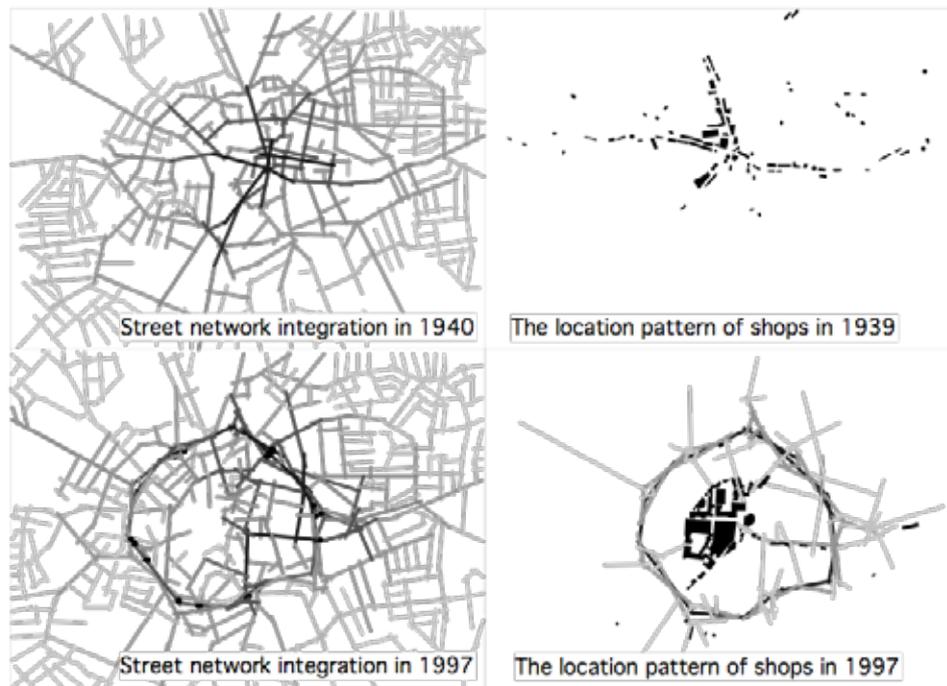|	
Street network integration in 1940	The location pattern of shops in 1939
Street network integration in 1997	The location pattern of shops in 1997

Figure 5 - Example on changes in the pattern of shops as an effect on changes of the street network in Coventry.

Due to these theories' strong causality relation, it is possible to use them to predict future economic related effects on spatial changes. The location of the Millennium Bridge and the regeneration of Trafalgar Square in London affected the flow of movement on various scale levels. These projects are good examples on how changes in a street network structure affected flows of movement. Conversely, the theory of the natural movement economic process makes also possibilities to explain where the shops was located and where the largest flow of movement took place in excavated towns where it is possible to reconstruct its whole street pattern (van Nes 2011). Positivistic explanation models, with a strong relationship between cause and effect makes possible to explain some specific effects on past spatial structures as well as to predict future specific effects on new proposed spatial plans.

5. RESEARCH CONCERNING SPACE AND SOCIAL RATIONALITY

As space syntax research has shown, high spatial integration implies high numbers of people in streets (Hillier et al 1993, 1998), high level of various economic activities (van Nes 2002), high building density and high degree of multi-functionality (Ye and van Nes 2014). What about high spatial segregation and cultural identities related to spatial structures? And what about identifying the spatial structures from archaeological sites or from different cultures?

An elementary scheme will set out how explanations as regards space and social rationality belong to a hermeneutic tradition. Hence, the subsequent argumentation assumes the models of von Wright, Bhaskar and Hempel to be valid, but tries to assess which of these models sets out the form of scientific reasoning essential to urban space and social rationality.

Von Wright's conditional causal explanation models rely on concepts of condition i.e. epistemological notions more basic than quantification and substitution. Research on space and social rationality or historical issues search for explanations in terms of reasons and consequences. But although a cause occurs before an effect, the effects are often easiest to identify. Hence explanations often set out from the effects to discover their causes. Here we will use examples from research on space and anti-social behaviour for revealing this issue.

Effect (consequences): High occurrence of anti-social behaviour takes place in post War social housing neighbourhoods

Cause (reasons): Post War social housing neighbourhoods have a spatially segregated street network

This schematic variety of a causal explanation apparently is too general. Research concerning social rationality is context dependent. In order to explain the occurrence of a particular phenomenon reference to concrete circumstances is mandatory. Therefore an example from a concrete case is used, presented as follows:

Effect (consequences): The Oosterwei area in Gouda is suffering from a high number of loitering youth on the backside of the area's shopping centre.

Cause (reasons): The backside of Oosterwei's shopping centre has a segregated street network with low degree of visibility from adjacent buildings.

As the example illustrates, research concerning space and anti-social behaviour heavily depends on particular examples. Combining von Wright's causal explanation model with Hempel's classical deductive-nomological explanation model results in the following rendering of the Gouda example:

Explanandum: The Oosterwei' area in Gouda is suffering from a high number of loitering youth on the backside of the area's shopping centre (effect).

Explanans: A segregated street network with low degree of inter-visibility from adjacent buildings shape opportunities for anti-social behaviour.

Explicatum: The backside of Oosterwei's shopping centre has a segregated street network with low degree of visibility from adjacent buildings (cause).

The model lacks a certain degree of predictability. When constructing a new neighbourhood with a segregated street network with low degree of inter-visibility from adjacent buildings today, it is difficult to derive from its implementation how its dwellers will behave. It is difficult to propose any kind of regularity or predictability as regards the influence of this particular segregated street structure on other urban areas.

In the first instance, research as regards space and social rationality requires studying the past to acquire an understanding of the intentions, which led to the occurrence of for example anti-social behaviour. Interpretations concerning their meaning, purpose and behaviour are supposed to ensue from their contextualised appearance. In this respect von Wright's concept of conditions is a useful tool to assess what kind of knowledge research on space and social rationality provides.

Von Wright has proposed several logical constructions of statements articulating a proposition's necessary or sufficient conditions. It seems difficult to assess the explanatory power on research concerning space and social rationality with causal explanation models. This kind of research intends to understand the intentions behind a certain type of behaviour, or a culture rather than explaining according causes. Subsequently, in research traditions belonging under the human and social sciences, the aim is to understand the reasons, intentions or motives associated

with these causes. In such cases, explanations as regards forthcoming effects like future city developments or certain kind of behaviour are not given. Accordingly, research on space and social rationality can merely state that certain changes will occur, though not tell in what way.

It seems appropriate to present research on space and social rationality in terms of von Wright's concept of intentionality and his model of teleological explanation. It might seem impossible to invest such a model with a certain degree of predictability for research on space and social rationality. But still a key for analysing its explanatory power could result from an analysis of the meaning of the explanandum (von Wright, 1971, p. 135).

Historical explanation: Non-human case — — — → Non-human effect

Causual explanation: Explanans ———————→ Explanandum

(human case) (human effect)

Historical explanation: Construction of Oosterwei with a segregated street net — — — → The occurence of anti-social behaviour

Causual explanation: Explanans ———————→ Explanandum

Implementation of the spatial principles from the CIAM 1933 congress

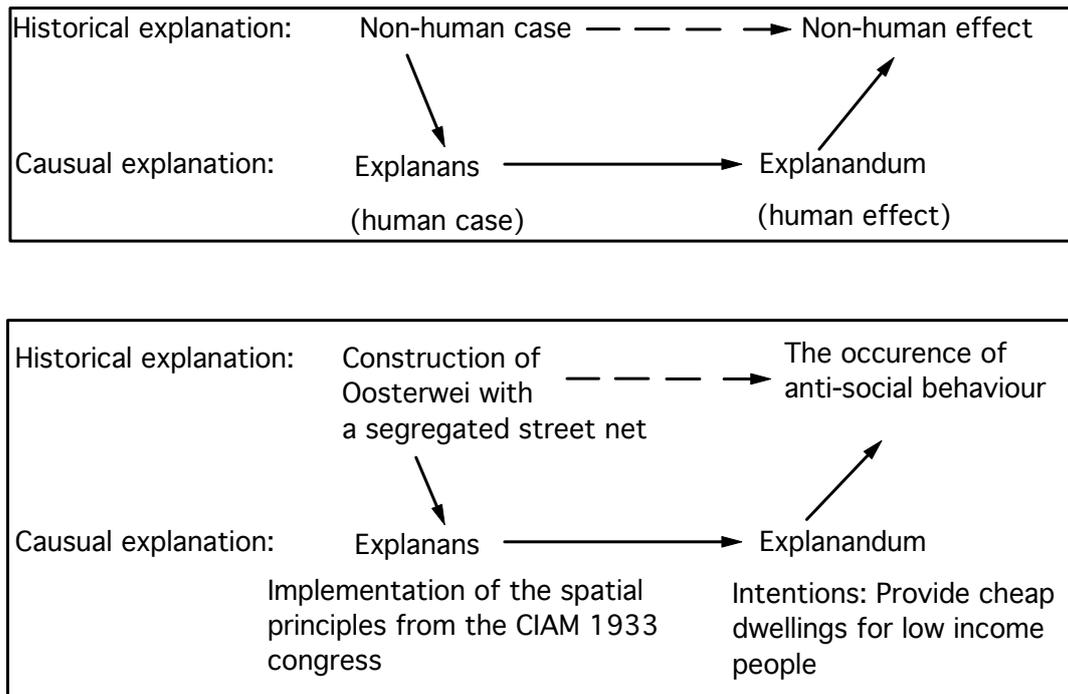Intentions: Provide cheap dwellings for low income people

Figure 6 - An example of teleological explanations

When knowing the intentions that brought about segregated street networks, it becomes easier to account for its effects even so it is not possible to predict them on behalf of these intentions. Research on space and social rationality is a historical approach. According to von Wright this involves that its explanatory power should be assessed in terms of *necessary* conditions due to which the effects at issue become *possible*. As implied, historical research such as research on space and social rationality can only examine particular cases.

Time plays a basic role in logical analyses of causal explanation models. Due to its temporal ordering the relationship between cause and effect is asymmetrical (von Wright, 1971, p. 41 and 47).

Research related to cultural, historical and social issues are dependent on already established urban areas. But it is impossible to predict how newly constructed neighbourhoods will function socially.

But in the main, historical explanations are concerned with the question as to how something became possible. They focus on a development's *necessary* conditions (von Wright, 1971, p. 58, 66 and 136). Causal explanations searching for *sufficient* conditions do not pertain to research in history or sociology. Von Wright set up an according model exhibiting the linkage between cause and effect when human will and intentions are involved (von Wright, 1971, p. 137). The explanatory power of research on space and social rationality depends both on human factors
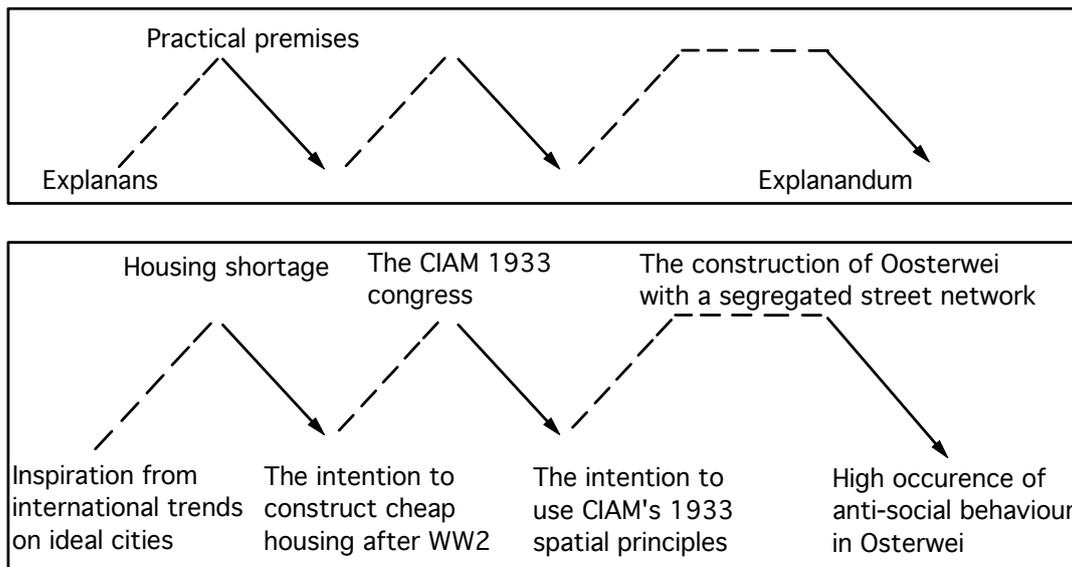
Figure 7 - An instance of quasi-causal historical explanation

like intentions and purposes and on the physical layout of a built environment. The diagram in figure 6 exemplifies how a concrete case from research on space and anti-social behaviour (below) presents itself in von Wright's model (above).

Human intentions or purposes and actual incidents often communicate with one another. Their nested interaction iterates. Von Wright illustrates quasi-causal historical explanations of this sort by the model presented above in figure 7 (von Wright, 1971, p. 143). Here a context dependent issue is used below to illustrate quasi-causal historical explanations. Each phase in an according process of understanding results in a new situation, which allows for new intentions and purposes. The process continues until the explanandum is reached. As this model shows research on space and anti-social behaviour is appropriate when an understanding of meaning and intention beyond the plan of a neighbourhood and its users is at stake.

Valuable understanding requires asking what was necessary for something to become possible (von Wright, 1971, p. 154). Historical incidents allow for further developments as they should transform intentions into effective action and, especially, by introducing new agents with new possibilities to influence their course (von Wright, 1971, p. 155).

5.1 RESEARCH ON SPACE AND SOCIAL RATIONALITY IS DEPENDENT ON NECESSARY CONDITIONS

How does von Wright's explanatory models with necessary and sufficient conditions apply for research on space and social rationality? As research of this kind pertains to context dependent situations, the following disposition parallels these schemata with a particular instance.

Von Wright: *p* is a sufficient condition of *q*.

The Gouda case: The will to implement the ideal city ideals from the CIAM 1933 congress was a sufficient condition for the segregated street structure of the Oosterwei neighbourhood.

Von Wright: *p* is a necessary condition of *q*.

The Gouda case: The will to implement the ideal city ideals from the CIAM 1933 congress was a necessary condition for the segregated street structure of the Oosterwei neighbourhood.

Of these two explanatory schemes the one with necessary conditions is more adequate. For an intention alone does not cause any particular action. However, it is difficult to assess as to whether the intention to implement the ideal city ideals from the CIAM 1933 congress was indeed a necessary condition for constructing the Oosterwei neighbourhood. It could be

that other phenomena were necessary for its implementation. Limited finances at that period equally could have been a necessary condition for that construction. Likewise the coincidence of the mentioned intention with prosperity could have been sufficient for the construction of the types of houses at Oosterwei at issue.

A complex sufficient condition consists of a conjunction of states of affairs (von Wright, 1971, p. 39). Von Wright describes the situation by yet another scheme, instantiated yet again by an example appropriate for research on space and anti-social behaviour:

Von Wright: Maybe p or r alone is sufficient for that q will occur. But if p and r occur together, q is sure to be there too.

The Gouda case: Maybe the intention to implement the ideal city ideals from the CIAM 1933 congress or housing shortages alone is sufficient for the segregated spatial layout in Oosterwei. But if the intention to implement the ideal city ideals from the CIAM 1933 congress and housing shortages occur both, then the construction at issue is sure to be there too.

Complex sufficient conditions thus are conjunctions, and, conversely, complex necessary conditions are disjunctions (von Wright, 1971, p. 39). In the case of sufficient conditions von Wright presents the relevant asymmetry by the following scheme, again instantiated by an example from research on space and anti-social behaviour:

Von Wright: If p or r is sufficient for that q will occur, then p by itself is sufficient and so is r by itself.

The Gouda case: If the intention to implement the ideal city ideals from the CIAM 1933 congress or housing shortages alone is sufficient for the segregated spatial layout in Oosterwei, then the intentions to implement the ideal city ideals from the CIAM 1933 congress is itself sufficient.

Again, the examples indicate that in a hermeneutic context the assessment of sufficient conditions does not have explanatory power. Research on space and social rationality is supposed to reconstruct the past and therefore has to search for intentions and purposes as conditions necessary for the development of a certain kind of urban area. In what way the spatial layout of a neighbourhood influence the social behaviour of its users is too complex to be derived and depends on extra intentional factors. Neither can one predict as to whether a certain behaviour will occur, nor can one assess in what way it will take place. The explanatory power of research on space and social rationality tradition can consist only in an identification of the intentions at least necessary for a given course of events.

5.2 PASSIVE EXPLANATIONS

Apparently research on space and social rationality does not provide active explanations for it cannot initiate what it is supposed to account for, i.e. the impact on human behaviour. Developments of this kind are being observed without any chance to interrupt or influence them. And it seems equally impossible to simulate them in computer models for they cannot account for the aesthetical values and intentions that influence the making of plans and the implementation process of these neighbourhoods. Finally, it simply is impracticable to design experiments concerning historical, i.e. past events. Active explanation models are thus not part of research on space and social rationality.

5.3 COUNTERFACTUALS

Yet another way of assessing a causal relationship consists in the use of counterfactuals. In this case a statement's explanatory power is specified by figuring out what would have happened if this proposed statement had not come about.

The Gouda case: If Oosterwei centre did not had a segregated street structure, the group of loitering youngsters would not be present on its streets.

A statement of this kind has little explanatory value. For other courses of events could have occurred that would contributed to loithering youngsters in Oosterwei's centre. When taking

human intentions and purposes into account, the counterfactual statement is as follows:

The Gouda case: If there had not been a will to implement the ideas for an ideal city from the CIAM 1933 congress in the planning and implementation for Oosterwei, this neighbourhood would not get a segregated street network.

Here the statement's explanatory power is increased. A counterfactual condition is set but in terms of human intentions being necessary for a certain development.

5.4 UNDERSTANDING THE INTENTIONS OF A CAUSE

As all these examples of explanations show research on space and social rationality does not lead to general statements on built environments due to its context dependency. For grasping the sense of a neighbourhood's spatial layout depends on understanding the cultural preconditions of their production.

A systematic analysis and interpretation of built form and meaning requires a hermeneutic methodology. For a society's ideologies, symbolic values, and attitudes constantly change and their articulation varies from one settlement, to another. An interpretation of how activities in a society shape urban space accordingly requires developing an understanding of both the built environment itself and its position in its comprehensive context. Interpretation processes that account for such interactions between parts and wholes of physical objects and their meanings are often called hermeneutic circles (Føllesdal et al., 1996, p. 105). As regards research on space and social rationality, this form of investigation consists at least in the following: identification of various spatial layouts, understanding them first in terms of the intentions that necessarily conditioned their existence, destruction or alteration and then in terms of the sense they acquired, finally assessing their relationships with a built environment in its entirety. Any progress in one of these phases leads to a refined or revised account of their meaningful existence in subsequent phases of the mention kinds.

In the first instance an according application of this basis method consists in proposing hypotheses about a built environment's structure. In its next phase it requires to search for an understanding of the historical contexts of the built environment's type of spatial layout. These can consist in political, economical, and societal circumstances as well as cultural preferences
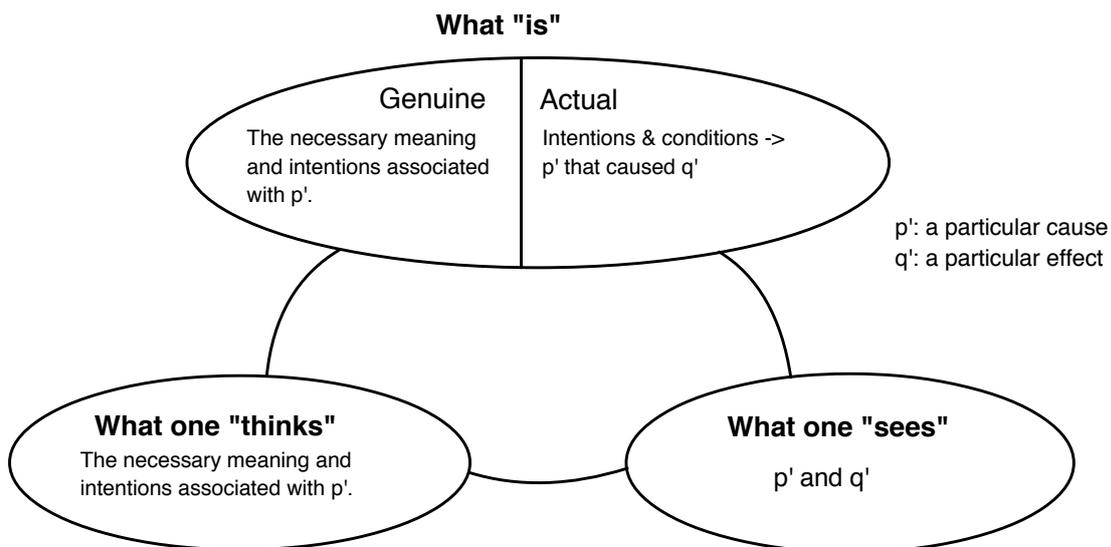

Figure 8 - Troye's revised explanation model

that were influential at that time the relevant spatial layout came into being.

As shown in figure 8 a revised presentation of Troye's model in figure 3 should thus reckon with von Wright's explanation models: one is supposed to search for an understanding of the meaning of a specific phenomenon *p* that caused *q*. It is impossible to say anything about how *p* caused *q*, even though it is possible to register *q*.

The sketch obviously pertains to research on space and social rationality. According to figure 8, a specific cause and effect of a specific phenomena can be identified on the "see" level. The cause is labelled *p'* and the effect is labelled *q'*. On the "think" level one is searching for an understanding of meanings and intentions members of a society had and that caused *p'*. This level represents the necessary conditions of the cause *p'*. The genuine part of the "is" level represents the invisible necessary conditions for the meaning and intentions for that the cause *p'* came into being. The way the particular cause *p'* and its effect *q'*, present themselves represents the actual part on the "is" level. The visible documentation of the identified necessary meanings, intentions and conditions that produced *p'* are also represented here.

Due to the context dependence of explanations belonging to a hermeneutic tradition, each *p'* with its according meanings and intentions has to be treated separately. The model in figure 8 cannot be used for gaining general statements on the relationship between meaning and intentions that caused *p'*.
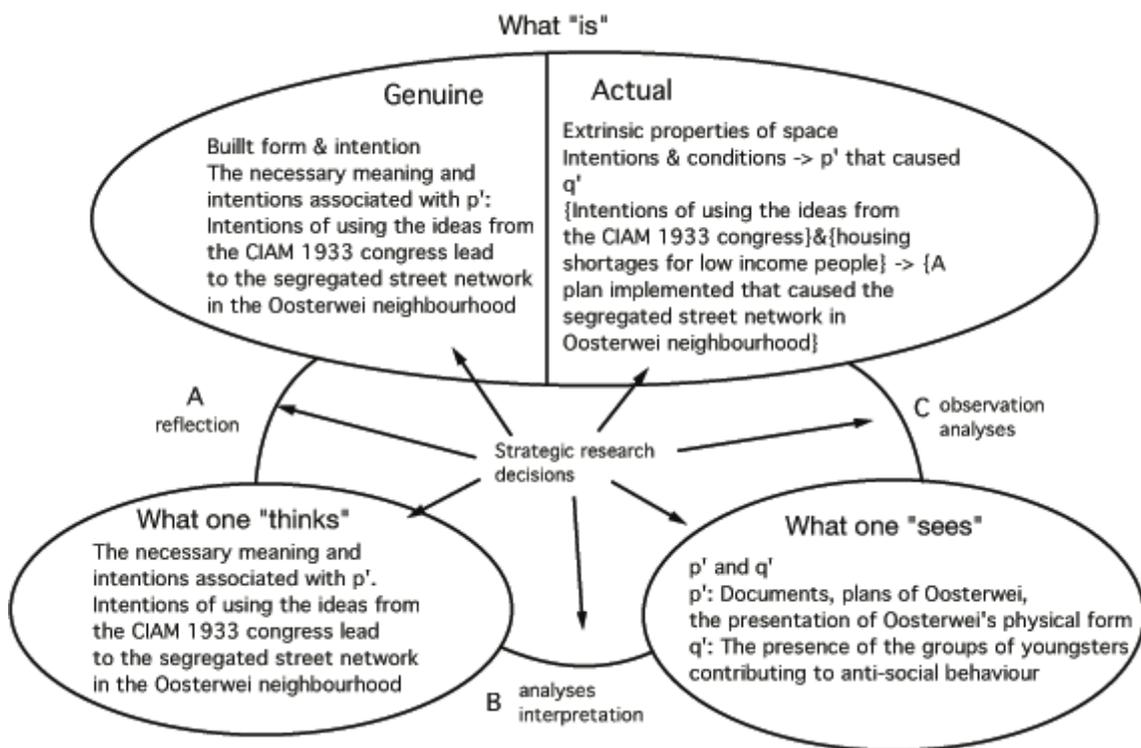

Figure 9: The explanatory power of research on space and anti-social behaviour through the use of Troye and Bhaskar's model.

Research according to this model has to consider a particular culture and its influence on the built environment. Under these circumstances, cf. figure 9, it seems adequate to use Bhaskar's critically realist model to account for research on space and social rationality.

Hence, the following can be stated: Society and its impact on the shaping and forming of the built environment needs a hermeneutic approach where the purpose is to gain *understandings*

on how activities in society influence urban form. Research of this kind is context dependent and therefore it is difficult to make general theories on the relationship society's influence on its spatial outcome. Conversely, how a built environment's spatial layout affect human behaviour requires both a positivistic as well as a hermeneutic approach. On research as regards space and marked rationality a positivistic approach is possible to gain explanations on how a built environment's spatial layout affect activities in society as regards movement and the location of economic related activities. The theory of the natural movement economic process and the theory of the natural urban transformation are examples on general theories able to *predict* effects of the causes. However, research on space and social rationality is context dependent.
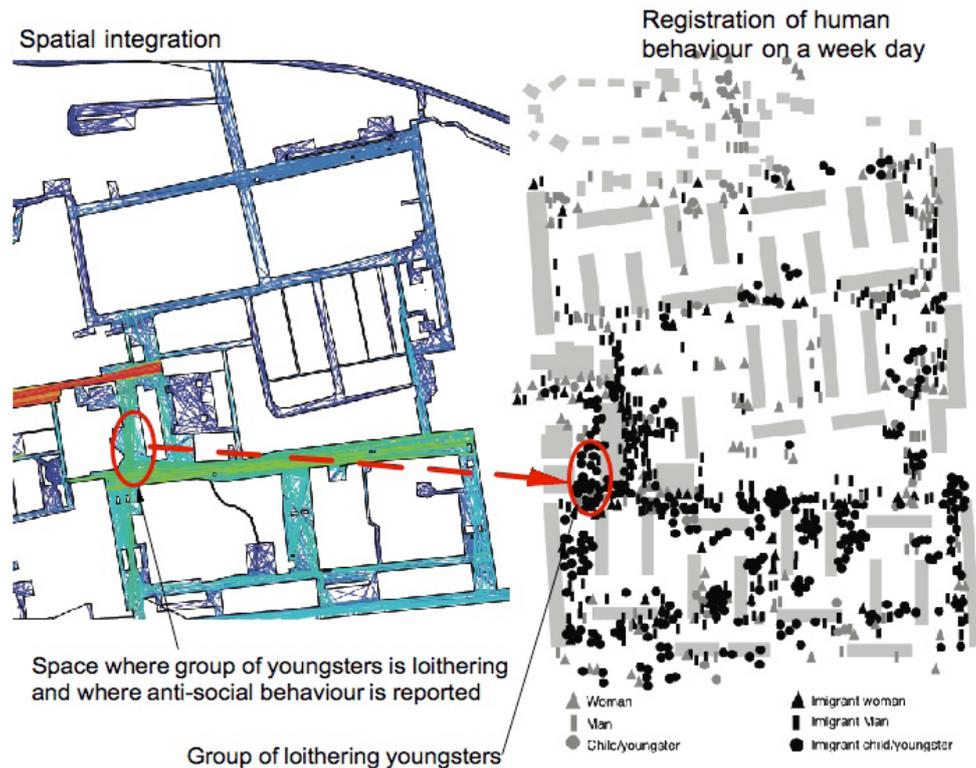

Figure 10 - The Oosterwei case in Gouda

Therefore, there exist no general theories on for example the relationship space and anti-social behaviour, or for example a theory on "space and crime".

6. CHALLENGES FOR THEROY BUILDING IN SPACE SYNTAX

What are then the challenges for theory building on built environments? Bill Hillier's main question proposed at the 10sss keynote paper: what are cities for? His answer was to create contact. For urban design and urban renewal issues, there is a need for a theory of the spatial conditions for creating contact. Here the theory of the natural movement economic process for *explaining* the location of economic activities and to generate many people in streets seems to be appropriate. One step further, a draft of a theory on the natural urban transformation process is already present. The aim is to explain how a natural urban transformation processes occur. So far, this theory's empirical support is based on big data on a couple of new and old towns in the Netherlands and China (Ye and van Nes 2014). Since the street network configuration is steering degree of building density and degree of multi-functionality, a causual explanation model is here used. The effects are that high building density and high degree of function

mixture is dependent on the spatial structure of the street network. Therefore, a change in the spatial structure of the street network is a sufficient condition for influencing building density and degree of multi-functionality in a settlement.

In general, research concerning human intentions that are unambiguous makes stronger predictability on the socio-economic effects of spatial interventions than research dealing with complex cognitive as well as socio-cultural factors that are heavily context dependent.

Most research on built environment has so far a strong hermeneutic approach. It accounts for place phenomenological approaches as well as for various morphological approaches. In the field of Space Syntax, research concerning space and crime/anti-social behaviour, historical and archaeological research, research concerning various social anthropological or cultural traditions' impact on urban space, and research dealing with spiritual/religious activities in relation to space, requires also a hermeneutic approach. The degree of predictability is not an issue here, and therefore there exist no explanation models or theories on for example the relationship between urban space and crime/anti-social behaviour. Understandings on these issues require investing already established areas.

Therefore, it is difficult to predict how for example new areas can generate safe urban areas or the opposite. As Juval Portugali writes, human beings are cognitive beings, where they can travel back and forward in time as regards their memory. That makes urban research a complex issue. However, the physical outcome – the built environment – is the media of interaction (Portugali 2013, p. 3). Therefore, theory building on how built environments works and set the framework for socio-economic life for human beings requires to be clear on the distinction between the physical form and the meaning, behaviour, memories etc attached to it.

What has Space syntax contributed to so far in theory building on built environments? In line with the positivistic tradition, it is obvious that Hillier's theories on spatial laws or combinatorics (Hillier 1996, chapter 8) have a strong link between cause and effect:

The principle of centrality: A central placed object increases the topological depth more than one placed at the edge.

The principle of extension: Partitioning a longer line increases the topological depth that a short one.

The principle of contiguity: Contiguous blocks increase topological depth more than separate ones.

The principle of compactness: Straight lines increase topological depth more than "curled" lines.

These principles or explanations focus only on the built environment as an object. Intentions and human rationalities are not taken into account here. Likewise, a first draft of a theory on the relationship between macro and micro spatial layouts of cities is proposed. It states that the higher number of direction changes a street has from a city's main routes, the more entrances from buildings are turned away from streets (van Nes & López 2010). At present, more evidence is needed to strengthen this theory.

Space syntax has been able to build some general theories on urban space and human behaviour with unambiguous intentions. The application of the theory of the natural movement economic process in research worldwide has shown that the location of economic activities and the flow of human movement are dependent on the spatial structure of the street network. At present, a first draft on a theory of the natural urban transformation process is on the table. Some evidence is present from Dutch and Chinese cases, but more empirical support is needed (Ye and van Nes 2014). The results so far show that building density and degree of multi-functionality heavily depend on the spatial structure of the street network.

What has space syntax contributed so far to general understandings on the relationship between society and its impact on urban space, or how spatial layouts affect activities in society? On the relationship between society and space, the following has been done:

The socio-anthropological approach: Contributions on understandings on how past cultures shape their spatial structure on built environments (Hillier and Hanson 1984) (Hillier 2016)

The historical approach: Understandings on the occurrence of societal, technical and economic changes through history and their influences on the spatial structure of built environments (Hanson 1998).

The archaeological approach: Connecting the location of artefacts and interpretation of spatial functions together with an interpretation of the spatial analyses of excavated towns (Stöger 2009, Crane 2009, van Nes 2011)

The urban planning approach: Political decisions, rules, policy and planning and building laws (van Nes 2007 and 2009)

The sociological approach: On the relationship between space and society, the following has been done (with a couple of examples of references):

- Understandings on the relationship between space and crime/anti-social behaviour (van Nes & López 2010, Shu 2002, Sahbaz & Hillier 2005, Greene 2003)

- Understandings on the relationship between space and cultures (Vaughan & Penn 2006, Aghabeick & van Nes 2015)

- Understandings on the relationship between space and behaviour (Rooij & van Nes 2015, Rueb & van Nes 2009,

- Etnicy, gender, sociological issues and the use/behaviour of the city (Vaughan & Penn 2006, Aghabeick & van Nes 2015, Nguyen & van Nes 2014), Powerty issues (Holanda 2012, Greene 2003, Mohammed & van Nes 2015)

- Understandings on the relationship between space and cognition (Hillier & Iida 2005, Conroy Dalton 2001)

To conclude, building theories on built environments based on space syntax research has both explanatory power components from the social and human sciences as well from the natural sciences. To illustrate this, Hillier's attempt to built a theory or understandings on the generic function of cities (Hillier 1996, 2016) has a positivistic as well as a hermeneutic component. Hillier's concept of the "foreground network" explains the location of micro economic activities, whereas his concept of "the background network" provides understandings on the relationship between culture and space.

REFERENCES

Aghabeik, L. and van Nes, A. 2015, "Ethnic groups and spatial behaviour in Rotterdam's neighbourhoods," In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium. London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London, pp. 102:1-102:17

Bhaskar, R. and Hartwig, M., 2010, "The formation of Critical Realism: A personal perspective," Routledge

Conroy Dalton, R. 2001, "The secret is to follow your nose. Route path selection and angularity", In: Peponis, J., Wineman, J. and Bafna, S. editors, Proceedings Space Syntax 3rd International Symposium, Atlanta.

Føllesdal, D. Walløe, L. and Elster, J. 1996, "Argumentasjonsteori, språk og vitenskapsfilosofi", Universitetsforlaget, Oslo.

Greene, M. 2003, "Housing and community consolidation in informal settlements: A case of movement economy." In: Hanson, J. (ed.), Proceedings of the Fourth International Space Syntax Symposium, London: University College London, pp. 38.1-38.24.

Griffith, S. 2015, "Reading the text as a city," In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium (pp. 102:1-102:17). London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

Hacking, I. 1983, "Representing and intervening. Introductory topics in the philosophy of natural science", Cambridge University Press.

Hanson, J. 1989, "Order and structure in urban design: The plans for the rebuilding of London after the great fire of 1666", Ekistics, vol 56, 334-335, 22-42.

Hillier, B. and Hanson, J. 1984, "The Social Logic of Space", Cambridge University Press.

Hillier, B., Penn, A., Banister, D. and Xu, J. 1998, "Configurational modelling of urban movement network", Environment and Planning B: Planning and Design, 25, 59-84.

Hillier, B. 1996, "Space is the Machine", Cambridge University Press.

Hillier, B. 1999a, "Computers and culture: The theory of the city as object", Bartlett School of Architecture, University College London.

Hillier, B. 1999b, "Space as paradigm for describing emergent structure in strongly relational systems", Bartlett School of Architecture, University College London.

Hillier, B. 2001, "The theory of the city as object or how spatial laws mediate the social construction of urban space", In: Peponis, J., Wineman, J. and Bafna, S. editors, Proceedings Space Syntax 3rd International Symposium, Atlanta.

Hillier, B. 2004, "Can streets be made safe?" Urban Design International 9 (1) 31-45

Hillier, B., Turner, A., Yang, T., Tae-Park, H. 2007. "Metric and topo-geometricproperties of urban street networks." In Kubat A. S. (ed.) Proceedings Space Syntax. 6th International Symposium, Istanbul Technical University, Istanbul.

Hillier B. and Iida, S. 2005. "Network effects and psychological effects: a theory of urban movement." In: van Nes A. (ed.), Proceedings of the Fifth International Space Syntax Symposium, Delft University of Technology.

Hillier, B. and Sahbaz, Ö. 2005, "High Resolution Analysis of Crime Patterns in Urban Street Networks: an initial statistical sketch from an ongoing study of a London borough". In: van Nes, A. (ed.), Proceedings of the Fifth International Space Syntax Symposium, Delft: University of Technology, p.01-28.

Hillier, B. Greene, M. and Desyllas, J. 2000, "Self-Generated Neighbourhoods: the role of urban form in the consolidation of informal settlements." In: Urban Design International, Vol.5 (2), pp.61-96.

Hillier, B. 2013, "The now and future of Space Syntax: From structures and models to theory." In: Kim, Y. O., Tae Park, H. and Seo, K. W. (eds) Proceedings of the 9th international space syntax symposium, Sejong University, Seoul.

Hillier, B. 2016, "What are cities for? And how does it relate to their spatial form?" Journal of Space Syntax Vol 6 (2) 199-212

Holanda, F. 2012, "Current challenges in LA cities." Keynote paper given at the 8th international space syntax symposium, Santiago, Chile. https://vimeo.com/35881357

Karimi, K. 1998, "Continuity and change in old cities; an analysis investigation of the spatial structure in Iranian and English historic cities before and after modernisation", PhD thesis, The Bartlett School of Graduate studies, University College London.

Koch, D. 2015, "…and avoidance." In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium. London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

Marcus, L. 2015, "Interaction rituals and co-presence – Linking humans to humans in space syntax theory" In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium. London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

Marcus, L. 2000, "Architectural Knowledge and Urban form", The Functional Performance of Architectural Urbanity", PhD thesis, Kungl. Tekniska Högskolan, Stockholm.

Mohamed, A., van Nes, A. and Salheen, M. 2015, "Beyond Informality: Traders as space experts in their own informal settlements." In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium. London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London, pp. 135:1-20.

Mohamed, A. and van Nes, A. 2015, "Space and protest: A tale of two Egyptian squares." In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium. London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

Moudon, A. V. 1997, "Urban morphology as an emerging interdisciplinary field", Urban Morphology, 1, 3-10.

van Nes, A. 2011, "Measuring spatial visibility, adjacency, permeability and degrees of street life in excavated towns. Excavated towns viewed outside archaeology", in: Laurence, R. and Newsome, D. J., Rome, Ostia and Pompeii: Movement and Space, Oxford University Press

van Nes, A. 2009, "Analysing larger metropolitan areas. On identification criteria for middle scale networks," in: Koch, D., Markus, L. and Steen, J. (eds.), 2007, Proceedings Space Syntax. 7th International Symposium, KTH, Stockholm.

van Nes, A. 2007, "Centrality and economic development in the Rijnalnd region: Social and spatial concepts of centrality," In: Kubat, A. S. (ed.) Proceedings Space Syntax. 6th International Symposium, Istanbul Technical University, Istanbul.

van Nes, A. 2002, "Road building and Urban Change. The effect of ring roads on the dispersal of shop and retail in Western European towns and cities," Doctor Scientiarum theses 2002:28, Department of Land Use and Landscape Planning, Agricultural University of Norway, Ås.

van Nes, A. and López, M. 2010, "Macro and micro scale spatial variables and the distribution of residential burglaries and theft from cars: an investigation of space and crime in the Dutch cities of Alkmaar and Gouda". in: Journal of Space Syntax, Vol. 1(2) p.296-314.

Nguyen, T. M. and van Nes, A. 2014, "Identifying the spatial parameters for differences in gender behaviour in built environments. The flaneur and flaneuwe of the 21st century" in: Che "genere" di città per il futuro, Vol. 6 n. 10 (Giugo 2013), Universita degli studi di Napoli Federico II, Centro interdipartimentale L.U.P.T, ISSN 1974-6849, e-ISSN 2281-4574

Portugali, J. 2013, "What makes cities complex?" Paper assessed 04.08.2016: http://www.spatialcomplexity.info/files/2013/10/Portugali.pdf

de Rooij, L. and van Nes, A. 2015, "The perceived safety and spatial behaviour in three different neighbourhoods in Rotterdam," In: Karimi, K., Vaughan, L., Sailer, K., Palaiologou, P., and Bolton, T. (Eds.), Proceedings of the 10th international space syntax symposium. London: Space Syntax Laboratory, The Bartlett School of Architecture, University College London.

Rueb, L. and van Nes, A. 2009, "Spatial behaviour in Dutch dwelling areas. How housing layouts affects its users' behaviour," in: Koch, D., Markus, L. and Steen, J. (eds.), 2007, Proceedings Space Syntax. 7th International Symposium, KTH, Stockholm.

Stonor, T. 2014, "From cities of movement to places of transaction. A new mobility focus for city leaders, planners & everyday users, Presentation given at the World Cities Summit Future Mobility Theme, Singapore, 3rd June 2014, Accessed 20.12.16: http://www.worldcitiessummit.com.sg/sites/sites2.globalsignin.com.2.wcs-2014/files/From_cities_of_movement_to_places_of_transaction.pdf

Troye, S. V. 1994, "Teori og forskningsevaluering: Et kritisk realistisk perspektiv", Tano, Oslo.

Vaughan, L. and Penn, A. 2006, "Jewish Immigrant Settlement Patterns in Manchester and Leeds 1881." *Urban Studies* 43(3): 653-671

von Wright, G. H. 1971, "Explanation and Understanding", International Library of Philosophy and Scientific Method, Lowe & Brydone Ltd., London.

Whitehand, J. W. R. 1981, "The urban landscape: Historical development and Management", Papers by M. R. G. Conzen, Academic Press, London.

Ye, Y. and van Nes, A. 2014, "Quantitative tools in urban morphology: Combining space syntax, spacematrix and mixed-use index in a GIS framework" Journal of Urban Morphology, 18 (2), 97-118.

Ye, Y. and van Nes, A. 2013, "Measuring urban maturation processes in Dutch and Chinese new towns: Combining street network configuration with building density and degree of land use diversification through GIS," in: Journal of Space Syntax, Special Issue, Urban Challenges. Space and society in the contemporary urban world.