Urban and regional design: a practical science

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Abstract

Widely held notions such as the uniqueness of each design and design situation and of learning the design craft in a studio with ‘apprentice’ and ‘master’ relationships, have hitherto left little room for thinking about urban design as a science.

In this paper it is argued that urban and regional design is basically a practical science like medicine, applied psychology and other technical sciences. In a practical science the objective of research is the application of science : research is focused on ‘what is possible’, be it desirable or not (yet) desirable. Practical sciences differ inter alia from empirical ones in that the concept of falsification (and conversely verification) has only limited application, owing to the complexity and heterogeneity of the concrete contextual conditions, and in some cases also of temporal and/or financial and/or ethical considerations. All these constraints apply in the case of urban design.

A heuristic research approach as developed by the philosopher of science Imre Lakatos is particularly suitable to develop a body of knowledge for urban and regional design, be it that the focus is on the context of discovery, instead of on the context of justification. Some examples of knowledge generated by this approach, in the form of ‘spatial organization principles’, are presented.

‘To approach a city, or even a city neighborhood as if it were a larger architectural problem, capable of being given order by converting it into a disciplined work of art, is to make the mistake of attempting to substitute art for life.’ (Jane Jacobs *The Death and Life of Great American Cities* 1961: 373)

Urban and regional design: a practical science

The field of urban and regional design

An implemented design of an urban area imposes long-term conditions on social processes, such as the opportunities people have to organize their lives in temporal/spatial respects in a healthy and safe living environment, and on the way social, cultural and economic institutions are able to function. ‘Cities are the largest and most complex objects that human beings make’ state Hillier and Penn (1991:2). In a world like ours, suffused as it is with scientific knowledge and its applications, one might reasonably expect the construction of these ‘objects’ to be scientifically based. This is all the more so considering that the functioning of neither people nor institutions can be described as trouble-free. Problems include the continued dispersal of regional facilities resulting in increasing traffic congestion (Klaasen and Jacobs 1999), the failure to create favourable conditions for mobility chains, inadequate use of location values (ibid.), ill-considered siting of metropolitan functions, the difficulty of accessing hospitals for people without private transport, poorly sited bus and rail halts, public spaces which are difficult to keep clean, windswept crossroads and perilous cycle routes. These spatial impediments are bad enough in themselves, but they also contribute to the inequality of opportunity among individual and social groups.

In the professional world, however, but for a few exceptions (e.g. Langenhuizen, Ouwerkerk and Rosemann 2001) little interest has been shown in scientific approaches to urban and regional design [1], certainly in recent decades. Widely held notions such as the uniqueness of each design and design situation, such as urban design being an artistic activity based on individual creative capacities or focussed on conserving our cultural heritage, have hitherto left little room for thinking about urban design as a science. Neither has the custom of learning the design craft in a studio with ‘apprentice’ and ‘master’ relationships.

One explanation for the non-scientific status attributed to urban and regional design may be the tremendous complexity of the ‘object’, the urban area. At the same time, the considerable inborn adaptive capacity of mankind undoubtedly plays a role too (Huisman 1996). Another factor is that people tend to regard urban and regional design as a special case of architecture - albeit on a different scale or concerned with public space, as opposed to architecture which is concerned with buildings (Meyer e.a.2000). Not surprisingly then, the aspect of experiential value (or ‘beauty’), possibly but not necessarily related to cultural history, receives as much attention in urban design as it does in architecture. For example, urban design, including regional design, is one of the artistic categories for which the Dutch *Prix de Rome* is awarded. This conception of urban and regional design clearly does not leave much room for a scientific approach to the field.

In as far as designers concern themselves with a science of urban and regional design, the focus is mainly on the process: the development of procedural theories for design. However, substantive scientific knowledge impinges rather on the context of the design activity: on formulating present and future social needs, on implementation processes and on the evaluation of implemented designs. Apart from collections of historical examples and certain checklists, scarcely any work has been done to create a theoretical base for design in the form of a systematically assembled body of knowledge which can be drawn on in the design process. Research into the phenomenon of the ‘city’ and into the development of this concept take place mainly in the sciences of geography, sociology and history.

To look upon urban and regional design as a form of architecture, however, overlooks the real difference between the way people experience a building, i.e. katascopically (from the outside inwards), as opposed to a city or city district, i.e. anascopically (from the inside outwards). The latter implies that the experiential value achieved is conditional on the use value. If for this reason alone, use value should take priority over design in the narrow sense when applied to cities or city districts (see Klaasen 2000). It must be borne in mind, however, that design in the narrow sense is an integral part of use value in that it provides support for the functional organization of the city. It helps people to find their bearings in and to identify - culturally, historically and personally - with their environment, and meets the need for aesthetically or otherwise attractive abiding and movement spaces.

Given that urban and regional design, seen from the standpoint stated here that use value takes priority over design in the narrow sense, is indeed a science, two questions arise:

1. What kind of science is it? And,
2. How can we build up a body of scientific knowledge?

Practical sciences

Every urban or regional design is unarguably unique. The same could be said of every patient who visits a doctor's surgery or psychotherapist, or of every design for a teapot. Yet medical, psychological or technical decisions are based on scientific knowledge. Teapots provide a conveniently tangible example (see Fig.1).

Fig.1: four 'teapot'models.

Pouring tea from these four teapots could be a precarious business. A knowledge of the physics of communicating vessels, whether explicit or implicit, would save a great deal of messy experimentation.

The uniqueness of each specific design cannot justify denying a scientific character to urban and regional design. Unique spatial patterns can be seen as constructions of reproducible 'building blocks'. These 'building blocks' must of course be adapted to the situation in hand, which means there is still room for design in the traditional sense.

In order to distinguish it from formal and empirical scientific knowledge, I refer to the kind of scientific knowledge for which I have used the metaphorical term 'building blocks' as an instance of 'practical scientific knowledge'. Practical sciences are those sciences which have the application of science as their object of research (Peursen 1986: 61). That is a different matter from the application of science to concrete cases. Similarly, a practical science, such as applied psychology for example, does not consist solely of knowledge obtained in practice (Drenth 1995:157). The same scientific rules and standards apply to both types of science: ‘both types of research lead to generalizable insights and laws. The difference concerns only the origin of the research question and the intention of the research.’ (ibid.:152). Or, as Thagard and Croft (1999:134) put it, ‘Despite the differences in the form of the questions asked ... , there is no reason to believe that the cognitive processes underlying questioning … are fundamentally different.’ The knowledge obtained through research is, as in an empirical science, in principle objective (intersubjective) in character. Subjective value judgements come into play only in a concrete application.

The object of practical science can be equally a process, such as an agricultural technique, or a product. In the case of urban and regional design, the product is the built environment (including infrastructure and recreational areas) and its relation to its environing natural (and possibly rural) systems.

Given the extrascientific problem definition, a monodisciplinary approach is unlikely to be fruitful in a practical science. A practical science is a task-bound ‘conglomerate’ of two or more (empirical and/or formal) sciences (Veen 1976:19). As an illustration, if we ignore the practical task of curing people, medical science falls apart into biology, chemistry, psychology etc. (ibid.).

The ultimate (critical) question that a practical science has to address is not ‘what is true?’ but ‘does it work?’ In more precise terms, does the knowledge yielded make effective action possible in specific situations - be it desirable or not (yet) desirable.

Invaluable in this connection is knowledge of the conditions under which action (leading to a product or process) is justifiable, and an understanding of intentional/unintentional (or desirable/undesirable) effects the action will have. Since practical sciences usually have a direct impact on society, the question of ‘does it work’ has to be considered in an ethical context.

The future state of affairs is thus a matter of concern both to the practical and empirical sciences, although from different perspectives:

empirical science	(intersubjective) knowledge	what will *probably* be the case	progress generated by intrascientific considerations
practical science	(intersubjective) knowledge	what *could* be the case	progress generated by extrascientific considerations

Figure 1: empirical and practical science compared.

Not everything that can become reality (‘the possible’) is indeed realizable in every possible set of circumstances (Peursen 1986: 97). This is a consequence of the fact that the knowledge is generalized in character, and peculiarities of specific situations have been ignored (Radder 1996: 2-3).

practical science	(intersubjective) knowledge	what could be the case in the general sense
application of practical scientific knowledge	decision taken in reasonableness	what is concretizable in a specific situation, given conditions and expected effects.

Figure 2: practical science and the application of scientific knowledge compared.

The conduct of science

The rules laid down, mainly in the twentieth century, for the conduct of science were formulated with the empirical sciences in mind. An important rule concerned distinguishing the 'context of discovery' from that of 'justification'. The 'context of discovery' was explicitly classed as external to science proper. Adherents of this view, which was introduced by members of the Vienna Circle, included Karl Popper. Popper instigated a revolution in the philosophy of the scientific method by rejecting the idea that science must strive to verify hypotheses, and replacing it by the idea of progress by the falsification of hypotheses. Increasing doubts were voiced from the 1960s onwards about the validity of this strict distinction as a criterion of science (for example Kuhn 1962; Putnam 1974; Urbach 1978). David Gooding (1996) argued on the basis of historical examples from the natural sciences that rationality and creativity do indeed meet head on in the 'context of discovery', when anomalies (unexplained deviations from current theories) give rise to 'abductive inference'. New hypotheses, he proposes, come about through complex cognitive processes.

This is not to say that there are standard recipes for generating scientific hypotheses, or that such recipes could be developed. There exists no algorithmic method, no defined set of rules, for obtaining new scientific knowledge, but the generation of new knowledge is not based on purely arbitrary processes: '… the search has turned to looking for "logics" in some weaker sense. Heuristic procedures, strategies for discovery, and the like are explored.' (Audi 1995 : lemma 'abduction'). Van Koningsveld (1976: 201) describes heuristics as the mass of suggestions, hints and unformulated rules that induce researchers to investigate some avenues of research as potentially fruitful while blocking off other avenues of research. Heuristic rules are rules of behaviour that promote finding things in the 'context of discovery' (Roozenburg & Eekels 1991: 42). Heuristic strategies like 'abduction' and 'plausible reasoning' make use of explorative models, analogies, metaphors, tacit knowledge and other non-empirical considerations (Radder 1997). The method of 'abduction', a term which originates from the philosopher C. S. Peirce (1839-1941) 'merely suggests that something may be.' (Hanson 1958: 85). 'The form of the inference is this: some surprising phenomenon P is observed; P would be explicable as a matter of course if H were true; Hence there is reason to think that H is true.' (ibid.: 86). Von Schomberg (1991: 58) proceeds from this to define 'plausible reasoning' as the derivation of a defensible standpoint from partly inconsistent data and/or in the absence of data. Models, in particular visual representations, play an important part in plausible reasoning. 'Visual representation is a powerful tool for science when sufficient constraints are incorporated into the reasoning process', Nercessian (1999: 20) stated at a congress titled 'Model-Based Reasoning in Scientific Discovery'.

Context of justification versus context of application

The realization that cognitive processes are at work in the 'context of discovery' is more important for the practical sciences than for the empirical sciences [3]. This realization creates room for the development of urban and regional design in a scientific direction.

As in the empirical sciences, efforts in practical sciences are directed at testing hypotheses and theories (empirically or otherwise) under controllable, repeatable conditions (a ‘lab situation’). In the practical sciences, however, one is less likely to seek a context in which the hypothesis or theory will be falsified as much as one in which it will be corroborated. On the basis of a series of applications, probable conclusions can then be drawn about necessary conditions and resulting effects. Hillary Putnam recognized this as long as 30 years ago: ‘Since the application of scientific laws does involve the anticipation of future successes, Popper is not right in maintaining that induction is unnecessary. Even if scientists do not inductively anticipate the future (and, of course, they do), men who apply scientific laws and theories do so. And don’t make inductions’ is hardly reasonable advice to give these men.’ (Putnam (1974) 1991:122).

There are several reasons why such a lab situation cannot always be created.

- Ethical considerations may prevent the experimental testing of a hypothesis of practical science, notably when people would be involved in the experiments.

- Sometimes financial considerations stand in the way, particularly where large ‘objects’ are concerned. The use of scale models may prove useful here, but one always has to be alert for the risk of ‘overstretching’ the model.

- Time, too, is a potential bottleneck in various respects.

- Experiments may require time that is unavailable because the requirement for effective action is too urgent.

- The conditions may be subject to long-term changes which cannot be artificially accelerated.

- Changes in conditions which occur in the course of time may also be extremely unpredictable, particularly for processes and/or products where a large ‘temporal grain’ stands in the way of long-term corroboration.

In situations such as these, one either withholds from applying the theory, or relies on the feedback from the application of theories in various situations with successively unique conditions. A series of applications can lead to conclusions (albeit cautious ones), in the manner of ‘under a certain range of conditions, it is not improbable that effect X will occur’, but only subject to the proviso that the conditions have a measure of consistency. If a certain assumption turns out to be inapplicable in practice or the effects are not the expected ones, there are two possibilities: either the theory is inadequate, or the specific conditions under which its application took place were misconstrued.

Since, if laboratory-type experiments are possible they delivery merely corroboration, and if only practical applications are possible these may occur under once-only conditions that are only roughly similar on each occasion, a scientific or at least rational underpinning of hypotheses (‘context of discovery’) is even more necessary in the case of practical sciences than that of empirical science. In the practical sciences therefore the term ‘justification’ loses much of its meaning. It seems more appropriate to speak of the ‘context of application’. This context does not supply a justification of hypotheses/theories so much as feedback for a heuristic approach to the ‘context of discovery’.

A scientific perspective for urban and regional design

I conclude from the points raised above that urban and regional design is, at least potentially, a practical science. However, urban and regional design occupies a unique place within the practical and technical sciences. This is because all the above-mentioned potential constraints on the 'context of justification' or the 'context of application' do in fact occur. A laboratory situation is uncreatable because of

- the large financial investment required before anything can be tested;
- the long time required for the implementation of proposals;
- the long period over which validity would have to be tested;
- ethical complications.

As to the 'context of application', the following complications occur:

- the conditions under which proposals are implemented in practice show relatively few similarities;
- the conditions cannot be even partially manipulated - there is very little ethical scope for experimentation in practice.

In this light, the conduct of the science of urban/regional design must concentrate on the 'context of discovery', on what is presumed to be *possibly* true. Empirical and formal scientific knowledge must supply the necessary constraints. This constitutes an answer to the first of the two questions formulated above.

Developing a scientific body of knowledge

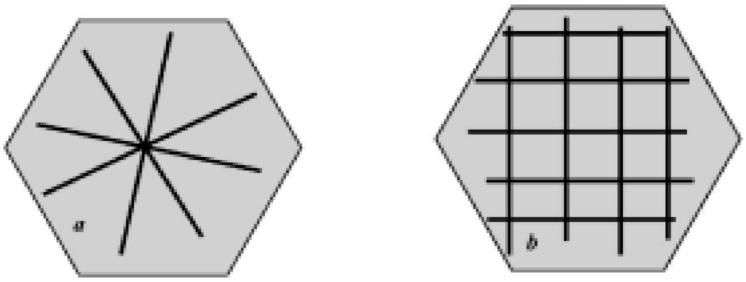
The second question, how can we go about creating a body of scientific knowledge, brings me, as a scientific realist (and how can one be anything but a realist in the practical sciences?) to the Popperian follower Imre Lakatos (1922-1974), most of whose work was only published posthumously (Lakatos 191976, 1978, 1999). Lakatos devised a heuristic approach in which the term 'theory', as a hypothesis open to falsification, is replaced by the concept of a 'research programme', which comprise both chains of theories and methodologies. He renounces the 'strict' falsificationalism of Popper. A research programme consists of a 'hard core' and a 'protective belt around the hard core' (1978: 104) . He follows Kuhn to the extent of proposing that the hard core should be considered temporarily immune to criticism (ibid.). He proves to be a true disciple of Popper, however, in the emphasis he places on seeking counterexamples ('monsters' – Lakatos 1976) to strengthen hypotheses and theories by a process of falsification (ibid.). Lakatos distinguishes two kinds of counterexample: local and global counterexamples. The first results in an improvement of the argumentation, while the second refutes the hypothesis or theory. This refutation is then used as a basis for seeking tacit assumptions implicit in the theory and making them explicit (because they may be wrong). He explains this methodology by reference to model-controlled thought experiments. 'A "model" is a set of initial conditions (possibly together with some observational theories) which one knows is *bound* to be replaced during further development of the programme, and one even knows, more or less, how. This shows once more how irrelevant "refutations" of any specific variant are in a research programme: their existence is fully expected, the positive heuristic is there as a strategy both for predicting (producing) and digesting them.' (ibid.: 51). Contrary to general suppositions, he demonstrates that deduction can lead to an increase of content. 'If a deduction does *not* increase content I would not call it deduction, but 'verification'. (ibid.:81).

Radnitsky noted in the 1970s that Lakatos' heuristic is a methodology that addresses the context of discovery. 'The structural study of hypothesis generation is not only compatible with but is suggested and guided by the Popperian approach' (Radnitsky 1979: 251 note).

Lakatos rules for the development of knowledge offer the prospect of scientific theorization in urban and regional design, considering the importance attached in that field to heuristics, deductive guesswork and the manipulation of pictorial (visual) models, which are recognized in advance as unimplementable but serve only to boost understanding. Not that the rules have to be followed to the letter, but they can serves as a general guide.

Some 'spatial organization principles' for urban and regional design

Research taking place in accordance with this guideline in the Urbanism cluster of the Delft Faculty of Architecture towards principles ('building blocks') for urban and regional design relates both to



'spatial organization principles' (a term devised within this research project) and to theoretical models for urban and regional scale designs. Some examples of 'spatial organization principles' are shown below.

Fig.2: organization principles for transport links: a. radial structure; b. tangential structure.

The universal spatial organization principles at city level are here, **a**. the radial mobility structure that is desirable to make collective transport possible, and **b**. a tangential structure that is necessary for private car transport. Collective transport calls for the 'bundling' of transport movements, while cars benefit from distribution, owing to their relatively large space demand both during driving and when parked. At a smaller scale, low-speed individual transport (walking, cycling) is once again availed by bundling and thus by a radial pattern. The bundling of transport movements creates opportunities for symbiosis (among other things public safety) along the routes and reduces the financial and spatial investment for a given link.

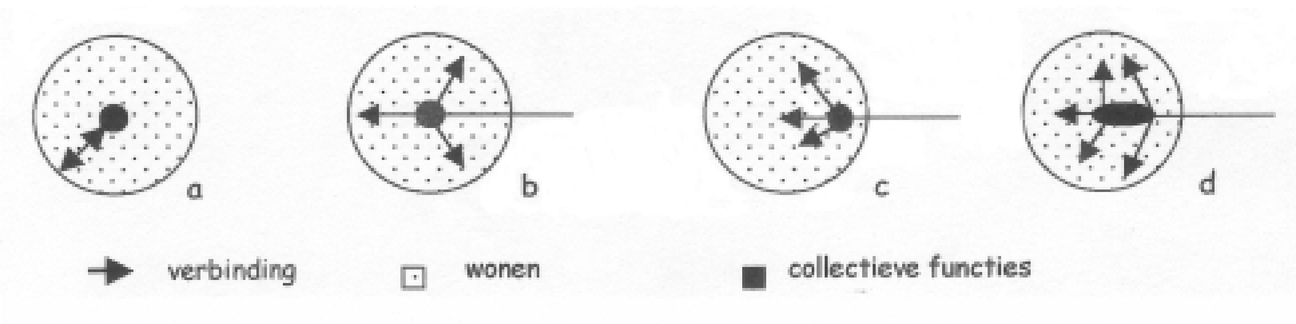


Fig.3: organization principles for the siting of collective functions at neighbourhood level.

In **a**, the centre of a circle is in a homogeneous situation, generally the most easily accessible place and thus appropriate for siting collective functions. The radius of the circle is a criterion for the functional spatial quality - the time and energy required for assumedly equivalent movement options (walking, cycling). The residential density and the surface area of the circle a joint criterion for the potential quality of the collective functions. In **b** and **c**, the residential area is linked to the outside world. All residents and visitors pass through a single entry point. In **b** the point is a bus or metro station, one of the collective functions that are situated in the central zone. In **c**, the entry point is e.g. a town-centre parking garage located on the edge of a pedestrians-only residential area. Example **d** has a combination of a bus or metro station and a parking garage. The zone between the centrally sited station and the eccentrically sited parking garage now has the highest location value for collective functions.

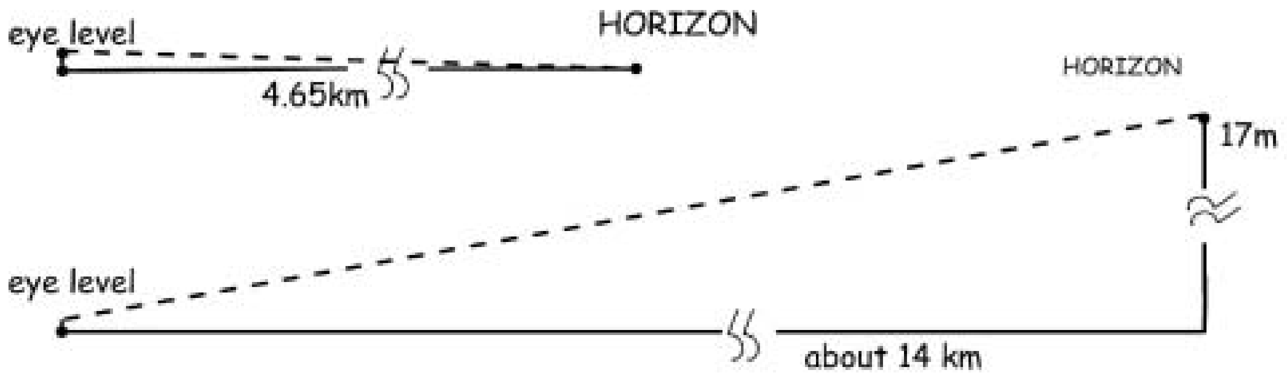


Fig.4: an example (at regional level) of a spatially determined - visual-spatial - organization principle.

The relation between the viewing distance and the visibility of spatial objects is affected by among other things the curvature of the earth. The connection between the height of an object and the distance at which it remains visible is non-linear. This is relevant both to the siting of features such as of landmarks and to the prevention of visual pollution.

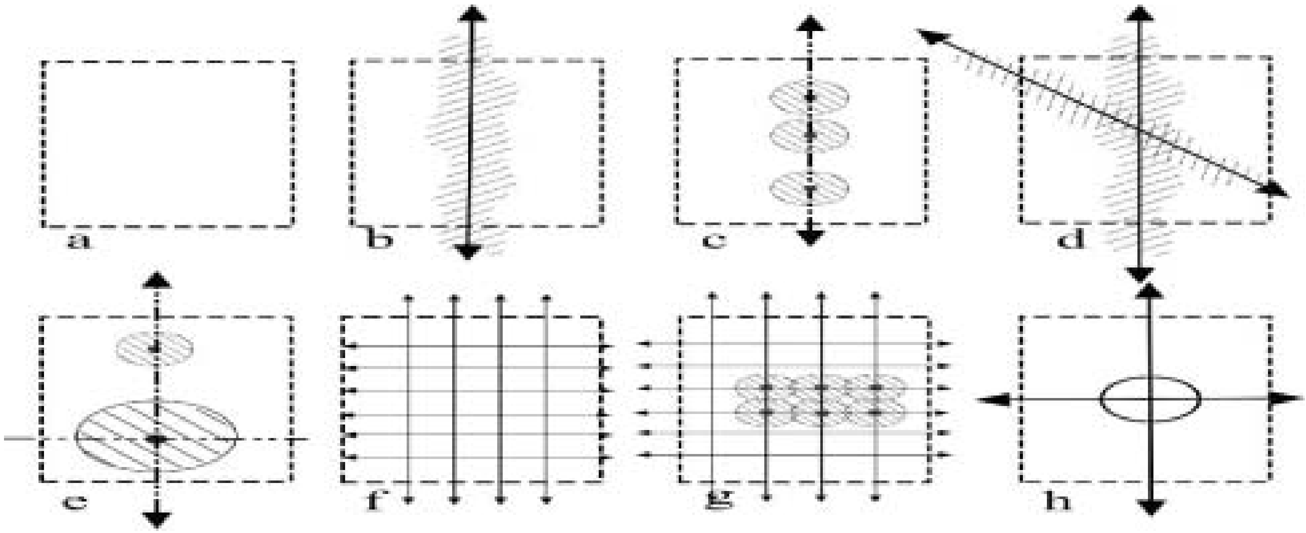


Fig.5: accessibility study.

a shows a limitless space that has not been made accessible. All points in this space are equal in terms of (un)accessibility. **b** depicts this space again but adds access by means of a road (individual transport). This makes a zone along the road accessible: say, the limits of the marked zone can be reached in 10 minutes walking at right angles to the road. In **c** access to the area is provided by a rail link, or rather railway stations (collective transport); the zone depicted in **b** has been transformed into separate (10 minute) circles around these stops.

The area around the crossing of the two roads in **d** is the most accessible site because it can be reached from four directions instead of two. We now have created a hierarchy in accessibility along the original path or road. The same goes for the railroad crossing in **e**. The crossings in both **d** and **e** are features of a radial system. Tangential systems on the other hand result in equality of accessibility. All sites in **f** will be accessible in at the most 10 minutes walking from a road. A tangential railway system on the other hand will still result in a variation in accessibility unless the users density is very high indeed, making overlapping circles possible (**g;** Manhattan?). In that case of course, private transport would be out of the question, as there simply wouldn't be enough room for all the cars. Transportation by bicycle, would probably still be possible. Private (car) transportation will probably already be problematic in the situation depicted in **d**. By adding a ring road as is the case in **h**, the resulting accessibility along this tangential road equals that at the crossing itself. It might indeed be even greater, depending on the quality of the radial roads inside its perimeter.

Notes

[1] 'Urban and regional design' is the translation of the Dutch term *stedebouwkundig ontwerpen* which I have chosen for the purpose of this paper. I have added the adjective 'regional' because the English term 'urban design' is mainly used in Dutch professional circles to refer to a scale of operation close to that of 'architecture'.

[2] Generalized knowledge does not have to be universally valid, but can also relate to a specific region in space or time.

[3] The 'context of discovery' is sometimes also referred to in the practical sciences as the 'context of invention'. I am not in favour of the latter.

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