# WAYS TO STUDY AND RESEARCH
## urban, architectural and technological design

### *Introductions on section*

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# CONTENTS

# A NAMING AND DESCRIBING



An important condition for scientific work is a conceptual framework and careful description of the subject to be studied. Naming, describing and referring are also essential constituents of study related to design.

*Naming components and concepts*
In their contribution, De Jong and Rosemann stress the importance of concepts in design, as well as their focus, supposed scale, possible overlaps. The lack of concepts in naming the mountain of possible forms and transformations whilst communicating on design actually is a problem for the science of designing. It causes a proliferation of neologisms, often not to be fathomed by outsiders. Definition does not always offer a solution. For that purpose the constituent concepts fail that are presumed when a definition is in the making. Defining is preceeded by the conditional positioning of concepts A and B *vis-à-vis* one another: which concepts A pre-supposes concept B to be defined? May concepts A be named?
It is important to avoid a change of level of abstraction in a discourse or use of 'legenda', the 'things to be read', in construction. Mistakes preceding logical ones like these often play a rôle when designs are discussed. Designers tend to use rather paradoxical expressions whilst commenting on their design, like 'concentrated deconcentration'. Words often fail to suggest the world of shapes.

*Retrieval and reference*
The contribution of de Jong and van der Voordt dovetails both practically and theoretically with suggestions *vis-à-vis* citations of scientific results and facilitating that.

*Descriptive research*
Lans and Van der Voordt explore the value of a painstaking description of reality for theory development and the practice of designing. They argue to describe facts or designs in such a way that, 'ex ante', a minimal amount of inter-connections is suggested. That description should be clearly distinguished from the interpretation of facts and the establishment of relationships. Criticism by way of comparing different interpretations of the same material depends on this in order to exist at all. Concrete examples of study illustrate advantages and disadvantages of the phenomenological approach. The authors advocate to raise the dominant form of design study – analyses of plans and comparison of previous cases – to a higher level. In addition, process description is discussed by way of two examples: the planning process of the '*Bijlmermeer*' project of the City of Amsterdam in the sixties, and the individual one, and one of thought as well, of a designer of architecture. Both studies yielded relevant insights for the theories of planning and of architecture.

*Historical research*
Macel shows that the results of historical research depend on the interpretation of history as a science. His contribution consists of three parts: 1) heuristics (how to deal with historical sources and references), 2) analysis (how to analyse text and drawings dating from the past), and 3) interpretation (focusing on issues such as context, typology, style and meaning). Finally he reflects on architectural history as a social science and the relationship between historical research and architectural criticism.

*Map Study*
Moens' contribution focuses on the formal and functional description of the earth's surface, on the basis of aerial photographs and maps. It discusses several types of maps; how they are made and how they may be used as support of design decisions. In addition, traps and foot holes are indicated in order to prevent faulty interpretation of the towers of map-making. Without interpretation, it could not be done at all. Just think about the 'things to be read', the units of the legend and choosing them. The degree and measure of interpretation is then at stake; and to what level they are suggested. Only after description the topographical facts should be placed into mutual relations according to a model. In the case of topographical maps of the military the problem becomes clear. Different connections are already pre-supposed in them; no longer susceptive to design decisions.

*Casuistry resulting in laws*

Most ancient social application of induction, a distinct set of cases within one general ruling, is the law. The juridical method where casuistry leads to jurisprudence is a predecessor of the scientific method. Facts, their modelling, debate and inter-subjective judgement play an important rôle.

Hobma and Schutte discuss the importance of legal study in the context of designing. On one hand they make practical distinctions, based on straight application of legal research: essentially retrieval and sorting; for instance for getting a building license. On the other, they deal with scientific legal study, explicitly aiming for a more general kind of knowledge.

The Chapter is consolidated in this section, while this prolegomenon from quarters not exclusively empirical gives a feeling for a scientific approach as it applies in the domain of architecture. An exclusively empirical approach fails to give a solution for many problems in this respect.

*Conclusion*

Together, the five sections reflect the value of descriptive study, the necessity of a clear, unambiguous terminology, and checking points to pre-empt all too subjective interpretations, or even faulty ones, of reality.

# B DESIGN RESEARCH AND TYPOLOGY



In empirical study the hypothesis functions as an object of verification in an existing reality. Establishing a hypothesis itself scarcely figures as an object of methodological thought. Usually the hypothesis of a study is considered to be 'free'. With the design as a hypothesis this would also be the case, if that would not result most of the time from the designers study.
The architectural design is nevertheless in all its stages a fact ('factum', 'artefact') in so far as it has been made with considerable effort; before it even functioned realistically enough to be checked. In its several stages of development an architectural design is not a real and working object. That enrichment is achieved 'ex post', when it is executed and put into a context of use; or when, 'ex ante', a mathematical or material model of it has been made for evaluative assessment. At that time the design has produced two things:

- the hypothesis 'This design will work', and:
- a reality or model to test this hypothesis.

Only if a design can be realised is it a model. The type entails the comparison of models. There are types of models, not models of types. Following the criterion of Quatremère de Quincy, quoted by Leupen (page ), the type is not yet a model. It can not be copied in reality. Like an intuition it can not act as a model for that reality. By the same token a processing by design is needed. That applies also, although less, for the architectural notion 'concept' in the sense of 'conception', e. g. aiming at communication and consensus between designers and members of the construction team before a design or model exists.

Therefore not every content of experience is a model. If the notion of a model would be that encompassing, it would lose its meaning and crucial applicability in sciences. What is a model then? In the present section different definitions are used. Not only spatial relations (form, composition) and connections (structure) may be read from a model. A model allows for effect analyses and critical evaluations before execution. If a hypothesis on existing reality – or a design for a possible one – is to be tested inter-subjectively, it is a model.

*Design research*
Van Duin and De Jong give a classification of possible studies when a context is determined.

*Designerly enquiry*
Breen explores what kind of study is needed before the design is ready for design research. How could we study design before it is a model to be realised and tested?

*Typological research*
A type is a tool, not yet a model. To elaborate a type into a design we still need a concept as Leupen will explain. Engel and De Jong give a classification of types. The design with a certain function satisfactory on this spot may be a failure elsewhere. How could we extract more context-independent types out of design research?

*Concept and type*
A concept summarises crucial elements of context and the object to be designed. Leupen explains the relation of concept and type in making designs. This making requires a 'technique' in the connotation of Ancient Greece (*teknè*, art, capability; *poèsis*, making). People who never designed will not be able to conceive of it while it is hard to transfer it verbally, in terms of mathematics, or even as straight pictures. This technique is increasingly supported by sketching and tutoring during designing, by specific computers programs, individually.

*Analysis of buildings and plan analysis*
Molema and Meyer give examples of analysing existing architectural and urban designs. There are more design methods than designers. The emphasis on design methods in the study of design of the sixties has shifted from process diagrams with stages and arrows to more spatial components: the toolbox of the designer, his means of design and the classification of design interventions.

*Design driven research*
Breen examines the potential for design driven research in academic environments. Making a design as such is part of the academic education in design; by the same token partial to design research. If the making of a design would not be the object of scientific study, a design education at the academic level would lack justification.

*Conclusion*
What may be studied in a design before a model of it exists? It is the model itself that should be made. Predecessors of the model do require attention here: the types, concepts, and other means of design. They are the main subject of this section; the next one will deal with the forming of the model following design.

# C EVALUATING



In addition to the intended effects of a design as they are formulated in the programme of requirements many effects not intended and further consequences may become manifest. This part of the book discusses if and how these effects can be predicted ex ante or be measured ex post.

*Ex post evaluation of buildings*
The effects of a design can be ascertained in the most simple and precise way after the building process, when the object has been taken into use. By that time circumstances in terms of policy, culture, economics, technicalities, ecology and space are also known. In these fields the effects must be evaluated seperately, and, furthermore, social debate determines the weight of each field. In the contribution of Van der Voordt en Van Wegen methods and techniques of evaluating research ex post are discussed. A lot of experience has been gained in this both nationally and internationally. The contribution focuses on a discussion of relevant themes for evaluation, linked to quality assessment and optimal matching between demand and supply. A combination is advocated of comparative description and analysis of precedents and the empirical measurement of the achievements of the building. Utilisation study in the form of Post-Occupancy Evaluation (POE), site visits and checking the design against the programme of requirements, norms and results from evaluative study done elsewhere are the most important sources.

*Ex ante research*
It is crucial to be able to make already during the development stage of the plan a guess into the effects of the programmatic choices and design decisions. Prophesying these effects before the object is realised (ex ante) is not simple. Hulsbergen and Van der Schaaf show that systematic analysis of effects in the form of evaluative study ex post may serve well. Such an evaluation necessitates formulation of a perspective within which the effects will manifest themselves; in political, cultural, economical, technical, ecological and spatial terms. Results from evaluating research ex post are an important source for so-called ‘pre-design research’. An excellent means to discover critical uncertainties is the study of scenarios wherein alternative views of the future are thought through with regard to spatial impact and their relationships to possibilities, desirability, and likelihood.

*Ex ante performance evaluation of housing*
Thomsen discusses an instrument to evaluate the quality of housing. This so-called cost-quality test is an important tool for evaluation of plans; both ex ante and ex post. Thus, not only the most important qualities in terms of usage are unveiled; also criteria for evaluation and assessment of the planned or realised achievement of housing and individual dwellings are highlighted. By relating quality to costs a motivated estimate can be of the optimal ratio between both.

*Evaluating prototypes*
Some of the advantages of ex post evaluation could be realised ex ante by making a prototype. Van der Voordt describes some criteria for that kind of research, illustrated by a study by design of prototypes of correctional facilities and health care facilities.

*Comparing and evaluating drawings*
In the final contribution De Jong shows how drawings can be used as a means to evaluate designs ex post and ex ante. He emphasises the importance of a clear legend and a transformation of different drawings to the same scale in order to be able to compare designs in different contexts.

*Conclusion*
The different contributions show that a long tradition exists in evaluating of designs ex post and ex ante. However, most evaluations of functional aspects are prepared and executed by researchers with a background in social sciences, whereas designers or architectural critics do most evaluations of formal aspects. Integrative evaluations including functional, formal, technical and economical effects might lead to a better mutual understanding of different parties involved in the design and building process and lead to a growing body of knowledge of architectural, urban and technical design.

# D MODELLING



In empirical science existing reality is modelled. Central in this section stands the making of consistent verbal, mathematical and visual models and their relation to reality.

*Modelling reality*
There are many types of models, as Klaasen will explain in the first Chapter of this section. It is highly significant, that several types of models are in existence, but not several models of types.

*Verbal models*
The best described, most widely accepted form of consistency is formal logic. This also is on a higher level of abstraction a model (meta-language) of common language. Verbal models of architectural objects carry on their own level as an object-language the properties of this model. In the corresponding section de Jong adresses proposition and predicate logic, and their linguistic restrictions.

*Mathematical models*
De Jong elaborates different mathematical tools to be used in architectural, urban and technical design and evaluation. In the mathematical model of a design, connections may be read that enable evaluation of constructive or functional connectedness.

*Visualisation and architecture*
The language of the drawing is, due to its endless variation, less consistent than conversational language with her verifiable syntax, grammar and inherent logic. Considerable sensitivity as to context and interpretation of the drawing implies both her logical weakness and heuristic prowess at the same time. Yet, consistent and verifiable visual models can be made. Koutamanis gives examples.

*The empirical cycle*
On a higher level of abstraction the empirical cycle is also a model; according to many – including the author of that Chapter, Priemus – the only consistent model for scientific practice. It can be copied in any research project. That model is broadly accepted. It is based on the growth of knowledge to be generalised by well-defined testing. The time consuming shaping of a hypothesis, like with the architectural design, is in this respect ‘free’, not further modelled. The usual scientific approach pre-supposes in its turn consistency in discourse.

*Forecasting and problem spotting*
Mathematical models play an important rôle in forecasts and consequently in problem spotting that may give rise, for example, to the formulation of an architectural programme of requirements. Their conceptual framework is explained in the corresponding Chapter of de Jong and Priemus by way of large-scale examples.

*Conclusion*
A model demonstrates more relations than a concept or type, let alone an intuition: it is more consistent. However the model is not yet reality and should not be confused with it. Many relations – topographical, situational – will be lacking in the model. Incomplete models of a design may be made in order to make sector effect analyses and to test the design according to certain values and objectives of the relevant stakeholders (evaluations). Sometimes this requires more modelling than the design itself allows. A scale model is a model, if it allows evaluation like that; very realistically, like in a wind tunnel. A sketched-scale model rather has a function for further development of the design; also if it has not, as yet, the consistency of a model with its inter-subjective checking potential.

# E PROGRAMMING AND OPTIMISING



Making a programme of requirements for a building or urban plan pre-supposes a model of the future. With the help of models discussed in the previous section, discrepancies may be signalled between the present situation and the most likely situation in the future and the most desirable one. Starting from a future model like that, urban, architectural and constructive programmes of requirements may be drawn up in order to deal with problems signalled or predicted. The programme directs the design, even if it determines the spatial model in a limited way. A programme represents a need from the context of the object on a certain scale level (e. g. national, provincial, local) and of a certain nature (e. g. cultural, economical, technical). Positioning the need in a contextual scheme is an important part of programming design.

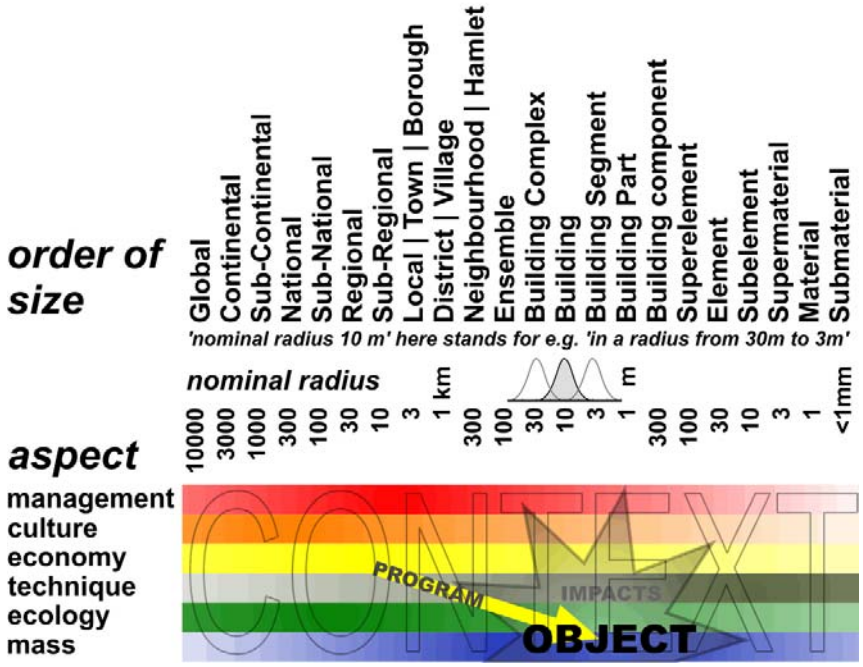


*Figure 1 Context*

*Urban programming research and programming of buildings*
In the contributions of Guyt and Hulsbergen (urban level) and Van der Voordt and Van Wegen (building level) the method of programming study is worked out further; not only for re-programming existing situations, but also for programming new architectural objects. Both approaches show a careful inventory of wishes, needs and activities to house. Study among present and future users, functional analyses, norms and characteristic values, lessons learned from evaluative study and statistical prognoses are important sources for formulating a programme of requirements. The use of scenario methods is a good tool to picture the spatial consequences of different possible futures.

*Programming building construction*
Eekhout and Cuperus discuss programming on lower levels of scale (<100 m. radius), but in the same time in a wide range (until 1 mm.) and within a more strict technical context of performance requirements.

*Designing a city hall*
The Chapter by Weeber, van Eldijk and van Kan is an example of a design process where the programme of requirements functioned explicitly as guidance for the design.

*Design by optimisation*
In a programme of requirements wishes and requirements related to an architectural object are often contradictory. In that case choices and priorities must be made. Decision theory has made a lot of progress in weighing conflicting requirements transparently and democratically. Van Loon shows what mathematical optimisation models can contribute. His contribution is focused on use of linear programming.

*Optimising performance requirements*
Houben describes a more verbal approach. In his view not only factual arguments matter, but – as least as important – also the way in which actors in the process communicate. An important distinction is the one between norms, laws and results from scientific study on one hand, and collective and individual preferences on the other. Rational and emotional arguments often conflict. Consensus under an umbrella concept and a phased development of the plan are important ingredients for taking decisions acceptable to all parties.

*The environmental maximisation method*
The contribution of Duijvestein argues not for optimisation, but for maximisation of dominant values, in this case: a safe, healthy and sustainable environment. With maximisation of an interest like that the importance of weighing interests of separate parties shows again.

# F TECHNICAL STUDY



Construction technique serves spatial design. It is also a subject of education, study and development. Designing includes construction-technical design; linked with all other subjects of this book.

*Re-design and renovation*
Presently the largest part of the built environment already exists; as soon as it is completed, a new building is added to the stock. An important dimension of the challenge of building for the future includes renovation, maintenance, re-adjustment and improvement of existing buildings (Verhoef, page **Error! Bookmark not defined.**).

*Study of building services and installations*
Schalkoort discusses the study of technical facilities in buildings most close to man: climate control, installations for transport, electricity, sanitary, communications, cleaning and risk prevention. The more space they require, the earlier its concern has to be involved in the process.

*Methodical design of load-bearing constructions in buildings*
Kamerling discusses the study of technical facilities more remote from man, sometimes even invisible. This kind of study covers a limited range of scale levels and limited context variables. The resulting clear-cut considerations could serve as a prototype of more complex design study.

*Classification and combination*
In this Chapter Cuperus argues that there are several ways to order building technique, each of them with a specific objective. Architectural transformations do not occur spontaneously. They result from human decisions, ultimately linked to the way components of the building are connected. One approach may be to order building along the lines of the ‘building node’. The interface of the building node defines not only an ordering for the levels where decisions will be made, but also one with respect to sub-systems.

*Methodology and component development*
Components (‘constituent parts of a whole’) may be part of architectural (sub-)systems and separately developed. Eekhout argues how, in which case and context.

*Industrial design methods*
Designing components resembles industrial design of loose products as done on the faculty of Industrial Design. De Jager refers to this branch of design methodology and discusses similarities and dissimilarities in context and methodology of product development, industrial design and architectural design.

*Future ICT developments*
Sariyildiz *et al.* indicate that both ‘hard’ and ‘soft’ computing techniques such as artificial neural networks, fuzzy logic and generic algorythms are helpful in complex design processes and architectural education. They discuss four application domains of ICT: creative-design, materialisation, realisation, and process and management.

*Conclusion*
Technical design is an interface between hard knowledge as discussed in the previous sections, and soft growing concepts. They are subject of the next sections.

# G DESIGN STUDY



As an inquiry into possibilities of a given context (site and programmatic desiderata) designing does not call for methodological requirements, but rather for liberation from down-trodden problem definitions and their solutions.

*Creating space of thought*
Hertzberger explores the methods assisting in opening up the possiblities, instead of determining them. Descartes' *'Discours de la Méthode'* focused on doubt. Design study distrusts, like classical sciences, all that is obvious, but does not throw everything overboard all at once. Experience evaporated into routine deserves suspicion of the scientific approach, deeming no pre-supposition sacred. However a culture, certainly a local one, surrounds us with pre-suppositions unbeknown to us; like a fish without knowledge of the water it is taken from, at the same time there is certitude of existing conditions: a table, a bed, a kitchen entails great forms of freedom.

*Perceiving and conceiving*
Because of this Hertzberger then appreciates greatly collecting architectural examples, references. However, awareness of these references requires a technique of reduction if they are to be used in a different context from the old one, and not at their beck and call.

*Formation of the image*
De Jong and Rosemann survey notions on the formation of images from scholarship, science, philosophy and the arts. Where do we cross the threshold from pure experience into making? Starting point is development psychology but the end is design.

*Experience, intuition and conception*
Geuze, Van Eldijk and Van Kan show the design process of a gifted student from analysis of the location until the final design with all its pitfalls and dead ends.

*Designing an office*
Brouwer, Van Eldijk and Van Kan then show a design process of an experienced architect directly starting with a concept, the influence of context, metaphores and fixing sizes

*Designing a village*
At last, Heeling, Van Eldijk and Van Kan describe the more formal design process of an experienced urban designer with a more global frame and grain.

*Urban design methods*
Enlarging frame and grain limits applicable methods, but, Westrik discusses so many methods in this field, that we can conclude that there are more methods than designers.

*Designing in a determined context*
Finally de Jong allocates them within the communicative maze of the building team.

*Conclusion*
There are more design methods than designers. Nevertheless, we recognise something in every design process. Though we can not name or systemise all phases, we can learn from it.

# H STUDY BY DESIGN



Design research as discussed in Chapter 10 concerns determined designed objects within determined historical contexts. Design study in the preceding section considers the actual context, the location and the commission for the time being determined as well, but the object is variable because it has to be designed.

| CONTEXT | OBJECT | |
|---|---|---|
| | determined | variable |
| determined | Design research | Design study |
| variable | Typological research | Study by design |

But, as we all know, context is always differing, changing and could even be object of design as well on a higher level of scale. Research on different locations and historical periods produces types (Typological research as discussed in Chapter 12) as long as we find object constancies. Sometimes we do not. Considerable experience has been gained in forms of study where the object or context is fixed by typological research or design study. If both context and object are variable (study by design), an alteration of typological research and design study can be resorted to. In this the object and the context are alternately varied. However, it is not inconceivable that this research can hold its own unaided by these two research methods.

*Types of study by design*
Van der Voordt and De Jong try to find some classifications of study by design. They do not choose but give some examples to find a scientific direction at last.

*Designing Naturalis in a changing context*
When the location changes during the design process, as happened designing Naturalis by Verheijen (see page **Error! Bookmark not defined.**), the type of building and even the programme of requirements may change as well.

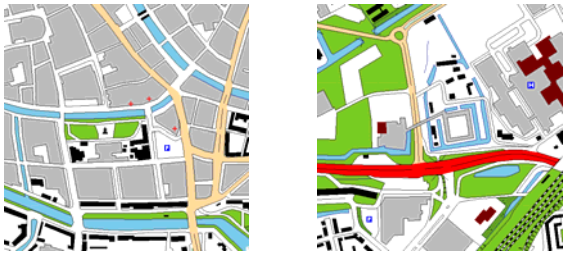

*Figure 2 Changing the location of Naturalis from downtown Leiden into the edge of the old city*

How do we study a variable object in a variable managerial, cultural, economical, technical, ecological and mass-space-time context? That means also, that goals out of that context are shifting. The study becomes more means-orientated and less determined by assumed goals.

*Designing a building for art and culture*
Röling, Van Eldijk and Van Kan describe the design process of an experienced and socially involved architect with great sensitivity for changing contexts

*Contemplations for Copenhagen*
Van den Bergh describes the development of a design without a programme of requirements. That brings him back to the very roots of the discipline of design, the ancient sources of our culture.

*Learning from The Bridge project*
((...))

*Creating non-orthogonal architecture and design in strategy*
Vollers' and Frieling's study are the first indications of systematic study by design. Vollers proceeds from the desing resources opened up by the use of CAD to give form to potential objects and applicable contexts. Frieling's basic premise is a dynamic public deliberation between projects on a small scale (objects), and perspectives on a large scale (contexts) in connection with the decision-making on the Delta Metropolis.

*Conclusion*
Graduation projects, in which the students are allowed to determine context and object themselves, present an archive of more and less successful experiments in the field of study by design. However, this archive is not yet sufficiently documented and updated, or accessible for scientific study (http://iaai.bk.tudelft.nl). Such an effort is necessary to find enough comparable examples for design research. Design research supports our most challenging effort, to bring study by design on a scientific level.