

This contribution explores the opportunities for *design driven* approaches to architectural research. Starting with an investigation into the broad domain of architectural design and its working methods, the relationships between design and scientific methods of research are explored. The discourse focuses on instruments and procedures that are suitable in order to approach design products and design thinking within a research context. It is argued that *designerly* modes of *enquiry* can offer opportunities for the benefit of innovative design driven research.

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## 11.1 DESIGN

How should architectural design be considered in a (scientific) research perspective? What are the aims of design activity? Can characteristic methods of design be identified?

The primary aim of architectural design (in the broadest sense) is the creation of shelters and surroundings which should be functionally and structurally sound and create a sense of 'place'. The result should ideally be visually pleasing and contribute to a sense of emotional well-being, creating room for human activity and experience. The classic pre-requisites formulated by Vitruvius: *firmitas*, *utilitas*, *venustas* (durability, utility and beauty), are generally still considered pertinent today.<sup>a</sup>

The act of designing is a form of creative *organisation*, which takes place on different 'levels' within an overall design *concept* (often simultaneously). A design is 'work in progress' which is gradually developed and refined from an initial idea to a built environment. In the course of the design process a designer will generate design propositions which are judged on functional, structural, material and aesthetic levels, to name but a few.

During a design trajectory intermediate (sub-)solutions are constantly being generated and evaluated in relation to the composition *as a whole*. This interactive approach - focusing on the overall composition as well as on its constituting components and details (and vice versa) - is characteristic of architectural design activity.

Designers work towards proposals which offer a fitting 'answer' to a specific context, a given programme and sets of economic constraints. At the same time they endeavour to create *authentic*, even *novel* solutions: end products which are experienced as more than a sum of separate solutions: as a *synthesis* of form, material and space (Kurokawa even suggests that design elements may be considered to co-exist in a state of *symbiosis*).<sup>b</sup>

In their work, designers address a variety of formal themes, such as: order and contrast; size and proportion; rhythm and (inter)space; symmetry and asymmetry; symbol and ornamentation; exploiting the expressive qualities of materials and the effects of light and colour, in order to shape new architectural objects and environments. On a compositional level this may involve creating visual *tension* between different, constituting parts, but the design ought not to be perceived as 'falling apart'. In a kind of 'balancing act' between order and chaos, the designer tries to achieve a form of *harmony* throughout the composition as a whole.

Alberti, paraphrasing Vitruvius: "*Beauty consists of a rational integration of proportion of all the parts of a building, in such a way that every part has its fixed size and shape, and nothing could be added or taken away without destroying the harmony of the whole.*"<sup>c</sup>

P.F. Smith: "*The most successful buildings are those which clearly express their elements, but which, at the same time, come across as wholes which are much greater than the sum of their parts. This is the primary aesthetic 'dialectic' in architecture. Aesthetic success demands that orderliness wins, but not too easily. There has to be sufficient complexity to make the perception of unity a worthwhile mental achievement.*"<sup>d</sup>

a Vitruvius *De architectura libri decem*. (from the English translation: Vitruvius and M. Morgan (1960) *Vitruvius: The ten books on Architecture*.  
 b Kurokawa, K. (1991) *Intercultural architecture, the philosophy of symbiosis*.  
 c Wittkower, R. (1952) *Architectural principles in the age of humanism*. p. 6.  
 d P.F. Smith in: Canter, D., M. Krampen et al. (1988) *Environmental perspectives: "The most successful buildings are those which clearly express their elements but which, at the same time, come across as wholes which are much greater than the sum of their parts. This is the primary aesthetic "dialectic" in architecture. Aesthetic success demands that orderliness wins, but not too easily. There has to be sufficient complexity to make the perception of unity a worthwhile mental achievement"*.

Fundamental to creative composition is *knowledge* and *understanding*. One needs to acquire cultural and technical knowledge and acquire *insights* into relevant design options and the effects of design *decisions*. Designing is a process of *searching* for a ‘correct’ result. This quest can be considered ‘empirical’ only in so far as that it tends to follow a path of *trial and error*. In a design process there is not one ‘correct’ outcome. The designer can come up with a *variety* of potential solutions, each of which would lead to considerably different environmental qualities and spatial experiences, if built.

Although the design process itself is clearly not ‘scientific’ in nature, the designer does make use of many sources of knowledge and information, which contribute to shaping the end product. In education, a proven method of acquiring knowledge and insight is the study of *precedents*, to be analysed systematically. Recurring formal themes and characteristic forms of variety make it possible to identify specific *types* of design artefacts. These can be organised systematically in design *typologies* which may in turn contribute to understanding and appreciation of *specific* design artefacts.

One of the most effective compositional structuring devices was traditionally the architectural *style*. In the Renaissance, the renewed orientation on ‘classical’ architecture of Romans and Greeks led to a set of stylistic rules which would not necessarily lead to the same result, but could be applied with a certain amount of freedom and inventiveness by different designers. After the emergence of the modern movement in the early twentieth century, the classical rules were declared obsolete. No generally accepted stylistic framework has taken their place. Although designers frequently refer to their knowledge of historical examples, and may at times *re-interpret* previous themes or even borrow directly from design examples, designers frequently attempt to cross - or at least to ‘stretch’ - existing boundaries. Design practitioners are constantly ‘re-inventing’ what was conceived before, within the shifting cultural (and technological) climate of the moment.

The cultural climate of the twentieth century *fin-de-siècle* seems to have given rise to a tendency amongst leading designers to keep surprising their audience with ‘original’ solutions in order to stay in the limelight. In contemporary architecture there is a tendency not to adhere to any pre-determined, binding themes - or indeed *methods* - of design, but rather to make choices within a framework of plan-specific design rules developed *per project*. The contemporary architectural ‘landscape’ offers both the familiar and the innovative. We bear witness to a constantly shifting ‘parade’ of architectural forms and themes. There is no generally accepted architectural style, no standard set of *rules*.

Architectural and urban plans are not created directly ‘in situ’, but are conceived, notated and communicated via specialised design *media*. Drawings and *models* are generated to explore and create insights into the ‘workings’ of the design. By learning to ‘read’ visual information design students develop the ability to translate ideas into form. Images are used to lay down ideas, this information can then be shared and communicated to others.

Design processes tend to be *iterative*, following a series of successive ‘loops’. At any given point, the ‘state’ of the design is evaluated in relation to previous steps and successively developed further. It is essentially a process of creative *imaging*, as Zeisel indicated.<sup>a</sup> Imaging is a form of communication with oneself (or with other partners in a design team), a way of questioning or verifying the merits of intermediate design ideas and developing new options and strategies. As such, the imaging process is a way of ‘channelling’ inspiration; the designer thinking while *doing* and reacting directly to ideas as they are being visualised, reflecting, eliminating and refining, subsequently making decisions and documenting the results. By determining *criteria* (frequently on the basis of ‘taste’) judgements are made concerning the *qualities* and *potentials* of different ideas.

a Zeisel, J. (1985) *Inquiry by design: tools for environment-behavior research*.

The working *methods* of designers may have been changed to a certain extent by the recent influx of computer aided techniques, but design *composition* remains a way of getting to the *heart* of the matter: a process of simultaneous development and testing of ideas, involving reflection, selection, reduction and perfection. There is no such thing as a ‘standard’ approach to designing. Although all sorts of themes are constantly (re)surfacing within design processes, design itineraries and working styles vary considerably, from one designer to another and frequently even *per* designer, depending on the kind of project at hand.<sup>a</sup> Viewed in this light, the *imaging* process, involving the active use of various design media, should perhaps be regarded as the most enduring *method* of design.<sup>b</sup>

## 11.2 DESIGN AND RESEARCH

What is the relationship between design and research? To what extent might design products be considered as research output? What are the characteristic aims and methods of design orientated research?

It may be clear that design is a broad field of enterprise that cannot easily be ‘tied down’. Working methods and formal composition tend to be determined by personal preferences and dynamic – cultural, technological, economic and ecological – developments (including fashions). The design process is not orderly and linear, but unpredictable and may – to an outsider – seem haphazard and erratic, even chaotic. Projecting scientific models of thought onto such a complex, varied and layered domain can easily lead to gross reductionism or simplification, in which case the – so called – ‘research’ findings will not be taken seriously by design practitioners or academics.

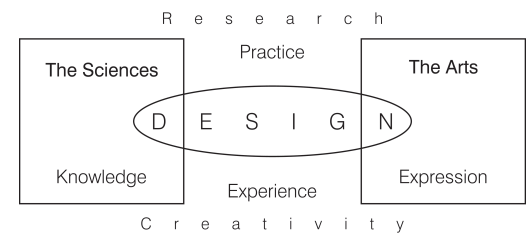
It is important to realise that *design practice* and *design research* are activities which, as it were, move in *different directions*, back and forth between (historical and contemporary) *culture* and (technical and applied) *science*. Architectural design is a development process which is both *creative* and *rational*, drawing from a wide range of knowledge and experience, concerning technical, practical and cultural aspects. An ‘in-between’ realm: broad and multi disciplinary; traditional as well as innovative; stretching into the domains of the Technical Sciences on the one hand and those of the Arts on the other.

De Jong: “*Some futures can be predicted, others must be designed*”<sup>c</sup>

Designing is essentially an activity of conceiving futures. Instead of looking back, designers are inclined to look towards ‘what might be’, they seldom look back in order to understand what has come to be and why. They apply their knowledge in a pragmatic way, but they are also inclined to ‘bend the rules’ for aesthetic effect whenever they consider it necessary. Such ‘poetic licence’ may be at the root of persistent objections to architectural design and research activity by conventionally inclined academics. However, it is precisely this tension between logical and aesthetic considerations that makes architectural compositions so *complex* - and therefore so challenging.

A design remains a mental ‘construction’ up to the moment it is actually built and begins to function within surroundings that have been altered by its introduction. In the unpredictable and iterative design process, various options are developed and ‘tested’; a process which is rational as well as intuitive. Designers base their conceptions on experience and knowledge but are often able to take ‘shortcuts’ and ‘bypasses’, using *intuition* fed by knowledge and experience. As such a design product is clearly not the same as research output. A designer is primarily involved in a creative process aimed at reaching a solution which is – in principle – ‘buildable’, whereas a researcher is involved with the evolvment of *knowledge* .

To put it another way: the ambition of *archi*-tects (the traditional ‘masters’ of the combined building disciplines - in present-day conditions often ‘creative directors’ of complex planning



61 Scheme 1: The in-between realm of design

- a Bakel, A.P.M. van (1995) *Styles of architectural designing: empirical research on working styles and personality dispositions*.
- b Breen, J.L.H. (2000) *The medium is the method: media approaches to the designerly enquiry of architectural compositions*.
- c Jong, T.M. de (1992) *When is designing also research?*

processes) is to create *architecture*; to achieve the ‘highest’ form of building production. Architectural *researchers* attempt to *understand* architectural thought and expression. Their ambition is to uncover the ‘origins’ and the ‘workings’ of architectural artefacts and as such they might be considered as ‘*arche-tects*’.

Architectural researchers have to ask ‘how and why’ questions. This involves fact-finding, systematic analysis and documentation in an orderly manner. However, it might also require thinking - and possibly even *acting* - along the lines of designers.

Inventive, innovative design research may call for the *re-searcher* to get ‘behind’ the architectural *search* and its results. A kind of ‘detective’ approach involving logical thought and systematic (comparative) analysis as well as less ‘stable’ forms of (designerly) enquiry, in an attempt to get behind the ‘event’.

Press: “*Research is the systematic investigation towards increasing the sum of knowledge which is reported in a form which renders both methods and outcomes accessible to others.*”<sup>a</sup>

De Jong and van der Voordt: “*Study is a collective term to denote the furthering of knowledge through profound thought, by carrying out experiments and by identifying and collecting subject matter which is processed and analysed systematically.*”<sup>b</sup>

Design research might aim at quite different areas of design efforts, like *product development* (devising new or better building components and technical solutions) or *practical applications* (aiming at the development of methods and new design tools), but a great deal of design driven research is aimed at *understanding* the workings and backgrounds of designs and design thinking. This is essentially *fundamental* research, even if the subject of study is by definition not ‘pure’, but *applied*.

Scholars find themselves confronted with an enormous *quantity* and *variety* of architectural artefacts - each with its own specific *context* and characteristic *synthesis* of space, form, material and detail. How should researchers set about exploring this extensive field of enquiry?

Architectural compositions are not necessarily ‘technically’ complicated. What really makes designs complex is the *inter-play* of different *sorts* of aspects within a relatively coherent ‘whole’. Whereas common scientific principles usually require the researcher to focus on specific, narrowly defined issues - which may be studied *intensively* - it often proves to be difficult for researchers to ‘unravel’ designs to such an extent that an unambiguous field of study, with clear boundaries, can be determined. For this reason, design research output is often viewed with scepticism by professionals from other disciplines, who may consider the outcomes too broad, longwinded and ‘fuzzy’.

For the sake of clarity, architectural researchers need to ‘narrow down’ their subject matter considerably. On the other hand, this should not lead to disproportionate *simplification* or abstraction. Without sufficient ‘context’, design research can easily become totally irrelevant in the eyes of design experts.

Henket: “*Designing is working across the width of a broad domain, science should attempt to investigate the connections within this realm of design.*”<sup>c</sup>

Jansen: “*Intensive study of a tiny bit of some item with a thousand facets, that leads to output!*”<sup>d</sup>

Duffy: “*Architectural knowledge does not ‘sit well’ in academic structures.*”<sup>e</sup>

It is not terribly difficult to paint a negativistic picture of the opportunities for design research in an academic environment<sup>f</sup>, but the challenge should be to *develop* forms of research which do justice to the kinds of mental activities and procedures that are fundamental to design.

a Press, M. (1995) *It's Research Jim*.

b Jong, T.M. de and D.J.M. van der Voordt (2000) *Criteria for scientific research and design*.

c Architect Prof. ir. H.A.J. Henket, speaking at the Architecture faculty, TU Delft, April 2000.

d Information Technologist Professor dr.ir. F.W. Jansen, speaking at the faculty of Architecture, TU Delft, May 2000.

e Francis Duffy: “The kind of architectural research I value most fits uncomfortably with academic models of what research ought to be.” Duffy, F. (1996) *The Value of a Doctorate in Architectural Practice*.

f Architect Professor Carel Weeber: “... at this university of technology people are mainly taken with empirical-technical research and the diffuse situation of architectural culture ensures that each research proposal is immediately branded as wrong by other architects. Thus, there seems to be no room at Dutch universities for design studies, and we may be relinquishing control of the development of the profession to journalism and the theorising of the art-historical sciences.” In: Weeber, C. (1992) *Dutch architecture today*.

Designers make use of their own arsenal of knowledge, insights and skills. These should not be ignored, but made operational in relevant, innovative forms of study. Designing – as an activity - can potentially be made instrumental in research, as long as the aim of such an application is the furthering of knowledge and understanding.

Matthews: “*There is a need to reclaim design research for designers. Too much design research has been conducted by technologists, systems practitioners, historians, psychologists, sociologists, anthropologists, organisation and management theorists. Too much design research has been research into design. Too little design research has been research conducted by designers doing what they do best - designing.*”<sup>a</sup>

An important requirement of an architectural *research* project - as opposed to a design process - is that it must be methodically *transparent*, as well as *systematic* in the way insights are gathered and subsequently communicated. The characteristically wide range of design endeavours should not be denied, but should somehow be ‘tamed’ for the benefit of research.

Most contemporary architectural research tends to be *descriptive*, often focusing on the oeuvres of individual architects or groups and their underlying ideological motivations. However, design research might involve *applying* design knowledge and experience in order to get behind the kinds of *considerations* and *choices* which determine the end product and to understand how such an object or environment is *conceived* and *perceived*. This has to include the characteristic *interplay* of compositional aspects. At the same time it means introducing certain *constraints*, which may narrow down the field of study, without this leading to reductionism or simplification. This must involve an attempt at identifying themes, defining meanings, establishing relationships and unravelling the complex patterns on the level of design composition.

Matthews: “*Design is not only a great orchestrator of knowledge, it constructs its own peculiarly polyvalent knowledge which makes visible and realisable the possibility of change.*”<sup>b</sup>

Duffy: “*It is absolutely necessary for architects to re-define architectural knowledge in a way which commands public respect. ... We architects need to invent our own models, our own future, in our own way*”<sup>c</sup>

Design clearly does not fit comfortably the kinds of empirical conceptions characteristic for scientific research. Design activity is not the same as research activity, but it can certainly *lead* to research. This implies that something must be *done* with the design product or process in an orderly way.

In this respect researchers should not simply try to *imitate* the working methods of other research disciplines. Design driven research projects require methods - or combinations of methods - which *do justice* to the nature of design, while at the same time learning from proven scientific methods, by adapting these or by finding suitable models and methods for design driven research. This means *designing* and *initiating* new forms of research.

### 11.3 DESIGNERLY ENQUIRY

What sorts of enquiry might be considered to be characteristic of design? What are the potentials for approaches involving controlled design activity in design education and design driven research?

Architects have a reputation of being far more interested in design(ing) than in research. Architectural practitioners are primarily concerned with the conception and realisation of built environments, inclined to move on swiftly to the next project, generally spending little time evaluating precise effects of their creations after they have been built.

However, the designer’s search for the right solution(s) is a venture driven by an *inquisitive* nature and a *creative* approach. To a certain extent the kinds of study carried out by a designer in the course of such a process might be considered a form of research, but the designer’s way of working and thinking is also quite different from familiar scientific research.

a Matthews, G. (1996) *Doctorates in Design? Why we need a research culture in design.*

b Idem.

c Duffy, F. (1996) *The Value of a Doctorate in Architectural Practice.*

The designer is involved in *problem solving*, using his or her imagination to develop - and indeed to predict - a *successful* final solution. However, design solutions are expressed not so much as conceptions, but as (proposed) *form*. The designer's thinking process is essentially a process of *transformation*. This 'search' involves a specific kind of active *exploration*, for which Bruce Archer has introduced the term *designerly enquiry*.

Archer: "*The idea of Design as a broad area of man's concerns, comparable with Science and Humanities, seems to be defensible in pedagogic terms. The idea that there exists a designerly mode of enquiry, comparable with but distinct from, the scientific and scholarly modes of enquiry seems to be defensible by the design methods literature*".<sup>a</sup>

Such a *designerly* way of thinking is typical of design. It is a kind of problem solving which transforms a relatively complex problem into a workable solution, which may be tested, judged and effectuated afterwards. Other activities requiring such *foresight*, like setting up a workable planning, developing an educational curriculum or organising a sound research experiment, could also be considered as forms of *designerly enquiry*...

The intellectual aptitude – usually denoted with *talent* – required for such *visionary* reasoning is not universal. Some people can be said to 'have' more *designerly* abilities than others. Design students are expected to have such talents, although it is not easy to recognise whether first-year students have the necessary capabilities. *Designerly* modes of enquiry deserve to be recognised as *intelligent* forms of enquiry, that it works and can be used in projects requiring problem solving directed towards creating a workable product.

What is of interest is if the *direction* of such enquiry can, as it were, be 'turned around': if *designerly enquiry* can be directed towards a better *understanding* of a product and the *sort* of 'solving' that went into it...

If so, it can be argued that this aptitude is not only necessary for designers in order to make designs, but also important for researchers involved in design driven research. If – as might be conceivable – this is not the researcher's 'greatest talent', it would be worthwhile to get others – more expert in *designerly* working methods – involved in research projects. In this context, term *designerly enquiry* seems appropriate, precisely because it has a certain, elegant *ambiguity*. It is a concept which can denote practical designing activities, but also suggests an '*as if*' designing approach, which may be particularly relevant in design education as well as in research *experiments*.

Design work needs to be carried out rigorously and conscientiously, if one is not to be confronted with 'unpleasant' surprises at the end. In this respect there is not that much difference between design and research. *Designerly enquiry* calls for (and to a certain extent is even *dependent* upon) *imaginative* insights. At the same it should be recognised that the working processes of design are relatively methodical and transparent, even predictable. On a 'creative' level, a design process requires both artistic and logical consideration, involving what David Bohm would regard as *imaginative* and *rational* insight and fancy.<sup>b</sup>

Hertzberger: "*Designing is a complex thinking process with its own possibilities and limitations, within which ideas are developed fairly systematically*".<sup>c</sup>

Which characteristics of *designerly enquiry* might be considered pertinent for other forms of study, like education and research? In the following overview four significant attributes of *designerly enquiry* are identified and discussed briefly.

#### 11.4 DESIGNERLY CATEGORIES OF ENQUIRY:

##### a. *Designerly decomposition*

As it is impossible for a designer to constantly address a design project as a whole, regarding all its facets with equal attention, there is a tendency to 'decompose' the design. The project

a Archer, B. (1981) *A view of the nature of design research*.

b Bohm, D. and L. Nichol (1998) *On creativity*.

c Hertzberger, H. (1999) *De ruimte van de architect: lessen in architectuur 2*, p. 28. English translation: (2000) *Space and the architect: lessons in architecture 2*.

is as it where ‘taken apart’ (and subsequently re-assembled), so that items of importance can be isolated and developed further in detail. The designer should be able to focus on specific *parts* of the composition and on *combinations* of parts in relation to the concept as a *whole*. In this way it becomes possible to recognise levels of priority and room for variation. By organising such information, decisions can be made relatively objectively. Essentially this attitude involves loops of successive decomposing – and *re-composing* – the project at hand.

*b. Designerly variation*

An important part of designing a project is developing forms of systematic organisation. Such project specific *structuring* devices set the tone for the types of compositional *variation* which are opportune on different levels. Finding the right dimensions, rhythms, proportions, subdivisions, connections, materials and colours (to name but a few) requires relatively systematic study. For this reason different variations (often on the basis of some identifiable theme or *motif*) are worked out, compared and evaluated. One of these ‘solutions’ may consequently be chosen, to form the basis for further designerly developments.

*c. Designerly visualisation*

Possible design solutions need to be *made visible*, not only for the benefit of the designer or the development team, but also for other ‘actors’ involved. Such visualisation, using design media is essential for design *communication*. Drawings and models can in a way be considered the primary ‘language’ of the designer. At the same time they form a kind of ‘laboratory’ involving (de)composition, selection and variation. The designer uses this visualisation ability to create impressions of the *effects* of potential design decisions, which makes choices *accessible*.

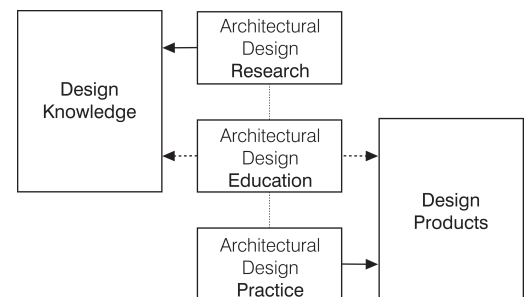
*d. Designerly reference study*

If an architect receives a commission for a particular kind of building - a museum, hospital, bank or housing complex - this usually involves extra ‘homework’, in order to get acquainted with specific demands, regulations and considerations. Designers often refer to *precedents* - usually more or less comparable, previously realised projects - which may be arranged in a kind of temporary ‘project library’. Such references allow for comparison with similar *types* of projects and solutions. Findings are not translated literally into the design at hand, but primarily allow for *reflection* concerning the merits of intermediate design solutions.

In a design process, activities such as those mentioned above help to keep the ‘thought experiments’ constantly carried out relatively orderly and transparent not only to the designer, but also to others. By determining *criteria* and *values* of certain design attributes, an objective judgement might be made concerning the relative *qualities* of different ideas. The *data* generated in such designerly study activities and evaluations can offer valuable insights into the underlying design process and benefit the *interpretation* of design results in education and research.

Whereas traditional design activities are primarily involved with development of design *products* and design studies with *knowledge*, in design driven education the processes are characterised by *reciprocity*. In the academic environment an ‘*as if*’ design setting is the norm, whereby design and research activities are primarily targeted at the generation of *knowledge, insights and skills*. Thus, the aim of designerly exercises, integrated into educational curricula, is one of *learning by doing*.

A traditional approach to teaching design involves requiring students - as ‘apprentices’ - to repeatedly carry out *integral* design tasks under the critical supervision of a ‘master’. With such an organisation, there is the risk of a ‘black box’ situation, with relatively little transparency on the level of the objective exchange of ideas or evaluation of results. A pedagogical alternative is to set up clearly structured courses which incorporate designerly activity, aimed at the *discovery* of architectural design themes. An effective way of ‘channelling’ student



62 Scheme 2: A comparison of aims in research, education and practice

activities towards research is by creating a kind of ‘game’ situation. Such a method has, amongst others, been promoted by Donald Schön and colleagues, who carried out explorative design exercises with considerable success at MIT.<sup>a</sup> The more clearly such tasks and objectives are defined, the more profoundly the students may be made aware of the constraints on one hand and the creative freedom on the other. An advantage of such a structured approach is that, in principle, results can be compared and the qualities of specific design solutions recognised and discussed. Examples of such a thematic, designerly approach in an educational setting can be found in the Delft Form Studies programme.<sup>b</sup>

The four designerly categories of enquiry mentioned earlier, common in design practice, can be used as - integral - parts of the didactic set-up of *educational* exercises (either with a design or a research emphasis), but potentially also in experimental design research:

*a. Designerly decomposition:*

The kind of decomposition which designers practice can be used most effectively in education by making such decomposition a part of the set *task*. This can come down to consciously not setting a complex, integral design task, but instead offering a more compact, clearly defined ‘problem’, to be studied in depth. An alternative is to make students aware of this approach as part of the *tutoring* method, or of a research approach and protocol.

*b. Designerly variation*

Designerly variation can be used in education as a part of the design *counselling* method. Such an approach can involve pointing out relevant themes or options, without necessarily suggesting an outcome. Such “could (also) be” scenarios can purposefully be developed as design variants, to be tested and discussed. Apart from using such an approach in design tutoring, designerly variation may be introduced as part of a research *task* and the accompanying procedures.

*c. Designerly visualisation:*

Active application of design visualisation techniques does not only constitute an important part of design activity, it is an essential component of education – and consequently can be made operational in design driven research. Essentially this approach involves creating *models* of (aspects of) the project which is being scrutinised. These may vary from physical models (from conceptual to detailed scale models), digital models (computer visualisations and simulations) to two dimensional representations (sketches, drawings, schemes, collages).

*d. Designerly reference study:*

In education and research, reference study can be introduced to shed new light on the project at hand. A process involving targeted *juxtaposition* of the subject of study and one or more projects or specific design aspects, allowing for insightful *comparison* and evaluation. This approach may include the use of precedents, but also of metaphors and even conscious development and systematic comparison with designerly variations.

Well organised – designerly - projects can help to create a kind of ‘laboratory’ atmosphere, in which procedures and results can be considered more or less empirically. Of course, the disadvantage of projects involving groups of students is their relative lack of *experience*. However, this is often compensated generously by their *candour* and lack of ‘hang-ups’, which can lead to refreshing viewpoints and surprising insights. Such educational projects may be considered promising in the context of design driven research.

a Schön, D. (1992) *The theory of inquiry, Dewey's legacy to education*. Habraken, N. and M. Gross (1988) *Concept Design Games*.

b Breen, J.L.H. (2001) *Designerly Approaches to Architectural Research*.