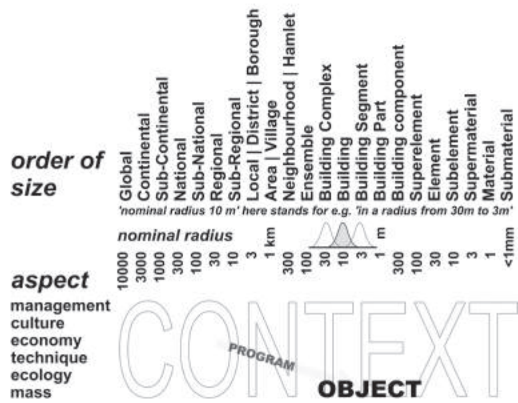
PROGRAMMING AND OPTIMISING

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.



285 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.

28 URBAN PROGRAMMING RESEARCH

PIET GUYT
EDWARD HULSBERGEN

Urban programming research aims to generate knowledge and data as input for the urban programme of requirements. Usually the urban brief focuses on the functions and measures in the urban plan. The quantitative programme of requirements determines what the design must realise. Qualitative aspects may concern liveability, sphere, safety, sustainability and so on. An urban planning programme can be written with or without research. Here, we assume that research plays a part. A research based programme of requirements does not come out of the blue, nor is it solely based on a normative idea of city form and function, but the contents are based on careful studies or well sustained argumentation. The next two paragraphs discuss characteristics of the brief and the focus of programming research. Next, two examples are described: the programming of amenities and of businesses. We end with concluding remarks.

28.1 ASPECTS OF THE PROGRAMME OF REQUIREMENTS

The programme of requirements depends on the actual context of a plan or design. Four aspects are useful as criteria for the discussion about the contents of the programme.

a. *Type of assignment*

A programme can be determined for a newly to-be-built area, but also for an existing built situation. The programme for a ‘new’ area may benefit from the results and information of ex post research in other, comparable situations concerning the functions and measures the urban plan has to meet. For an existing area the situation is different. There, the built environment can be described in terms of the realised, existing programme and the developments afterwards. Research of its effects may clarify the formal and functional defects and positive points. This existing programme forms the start of the re-programming. The new programme can be based on the effects of spatial interventions elsewhere, and contains necessary adaptations, improvements and modernisations.

b. *Programme elements*

The elements of the urban programme are derived from the desired functional-spatial organisation. They can be expressed in a quantitative and qualitative way. Reference images can be used as illustration or guideline. Programme elements concern structure of the area, functions and form:

The *structure* includes infrastructure and the structure of amenities, green and water. The structural part of the design is the well-considered composition of these component structures.

The *functions*, like housing, amenities (shops, restaurants, schools, hospitals, theatres) and workplaces, can be classified in several ways. With respect to amenities one can discern for example free and compulsory, mono- and multi-functional, competing and complementary amenities. The functional part of the design concerns the well thought out tuning to each other. The functions in a plan area can be on one hand the (‘autonomous’) starting point, for instance the amount of houses; on the other the ‘derived‘ functions (e.g. amenities) based on the population in the given amount of houses. This relationship can be expressed in indicators (rules and numbers of thumbs) for instance: x m^2 per inhabitant. It must be emphasised that one should be very careful in handling these rules of thumb. There can be great differences between actual situations (see below: programming of amenities).

The programme must also express the demands about the actual number and *form* of the buildings and outdoor spaces, leaving space, however, to the creativity of the designer.

c. Functions and questions

The functions mentioned can be divided into categories, for instance according to the CIAM-classification. With respect to them several questions need to be answered:

Housing: How many houses and which types are needed and for whom? Which density shall be used, and why?

Employment: Which type of activities can be included in the planned area? Where? What are the advantages and disadvantages? What are the requirements of the businesses themselves, and the wishes of inhabitants with respect to companies? Aspects that can play a rôle are diversity, identifying marks, liveliness and the presence of facilities.

Amenities: Which amenities (shopping centres, schools, sports centres, playgrounds, churches, social and cultural amenities, recreation areas, hotels, restaurants, hospitals, entertainment centres) are needed, and how many? Just for the people in the area itself, or also for people living in the surrounding neighbourhood, visitors, and tourists?

Traffic: Which road structure, parking, type of public transport and so on will be required? How can the modal split be influenced?

d. Dealing with uncertainty

If the outlines of the plan are clear and the programme ready, it can be worked out in a design, for example a certain density of houses, and an amount of amenities. However, one problem might be how to deal with uncertainties about the specific organisation or the future developments. In the case of uncertainties the solution is to reserve space for a specific function.

28.2 FOCUS OF PROGRAMMING RESEARCH

The focus of programming research depends on the need for information and the decisions to be taken.

a. Demand or supply

The programme can be determined from the demand side. Generally, the preliminary magnitude of the demand is determined with the help of index numbers(rule of thumb(planning)): simplified rules and relations between variables, based on general research.[a] However, general index numbers do not take into account the specific information of a particular local situation. So one should be very careful in handling these index numbers. If one does not take into account from what situation the rule of thumb is derived, great planning misfits may occur. An example: a ratio between space for parking and space for shops in a shopping centre was used for a centre planned in a new town in The Netherlands. Later on, it turned out that the ratio was derived from a situation of a different type of shopping centre in the United States, where the modal split is totally different, and where cars are larger than in the Netherlands. Also the type of shopping centre plays a rôle, because of a possible difference in average duration of the visit. The longer the visit, the more space for parking is needed. Another example: one cannot use a fixed ratio between number of inhabitants and the number of m^2 shopping space. The ratio depends on what the influx or outflux of purchasing power is. Rules of thumb can only give indications of what is needed to some extent.

With respect to the actual programme in a particular planning situation, information can be obtained by research in that area, by observations, interviews with key persons and discussions with clients. Nevertheless, uncertainty will remain to some extent. It is important to handle this uncertainty by scenarios[b], monitoring and flexibility in the design (see Hulsbergen and Van der Schaaf on ex ante research on page 159).

Programming research can also start from the supply side. In the inter-action between programme and design the programme possibilities can be explored. One must bear in mind that

a NIROV (1988) *Planologische Kengetallen 1988-2001* (regularly revised).

b Draak, J. den (1993) *Van blauwdruk naar draaiboek, scenario's in de ruimtelijke planning en volkshuisvesting.*

for certain elements a “critical mass” must be part of the evaluation of the outcomes. This is a kind of research with the help of design (design study / study by design), where designing is interpreted as hypothesis. An example of a plan in which the design was determining the programme is the well-known Kop van Zuid in Rotterdam. In this context we can point out the difference between programmes that are following existing trends and task setting programmes. The task setting programmes relate to programmes, that are greater than the estimated need for a certain location, for instance based on considerations on a higher scalelevel. The design can be a means to show the potentials of an area, and be used to approach or even reach the chosen goals.

b. Present or future situation

Programming research not only concerns estimation of future developments, for instance population growth and income growth, but also analysis of the way certain amenities, for instance a shopping centre, function now and in the future. Synergy between several kinds of amenities, financial feasibility and location play important rôles. It is also possible that an amenity is placed not only because of the need for this amenity as such, but because of other purposes: e.g. fighting deterioration, vandalism and criminality.

c. General or specific plan orientated research

Programming research can focus on general questions and general knowledge. For instance: how is the development of the demand for offices? What are important factors determining the location of businesses? On the other hand, programming can focus on a specific plan. What are the needs of prospective tenants (see also paragraph 1c)? An interesting question for ex post evaluation is for instance: which similarities and dissimilarities turn out between expectations, ambitions and planning tools (like index numbers) in advance, and actual use and perception of a certain area? How did the design function? This knowledge may be used to improve the area itself, but also to add knowledge to the existing ‘body of knowledge’, as input for a particular urban brief or to include in the decision-making process.

d. Financial aspects

The rent to be paid is one of the factors influencing the choice of businesses and amenities for a specific location. Industries needing a lot of space especially will pay much attention to the price of the land. Businesses and offices that can afford to pay high rents push away weaker functions from preferred locations (displacement). In areas preferred by functions that can afford to pay high prices, the ground exploitation is no problem generally. In case of ground exploitation problems in a certain plan area, the local government can decide to absorb functions (offices, amenities) that can pay higher prices.

e. Methodological aspects

Firstly it should be taken into account that the results of research may be rough or detailed depending on the phase of the planning process. This means that the research outcomes may differ in desired precision, reliability and range of the results. However, the information must always be collected and analysed properly. The conclusions must be based on the information used. The approach can be empirical (statistics, inquiries, interviews and observations) or with the help of models, for instance mathematical formulae describing reality in simple terms. Examples of models are gravity models or models that describe the division of purchasing power in a region or city. Whatever the method, one should be very critical with respect to the reliability of the used information (for instance based on inquiries, interviews), and the application of outcomes.

28.3 PROGRAMMING OF AMENITIES[a]

Programming research with respect to amenities needs understanding the phenomenon in question. The concept of the supply structure: the network of the amenities in relation to the consumers is important. This structure has several levels (the quantitative and qualitative composition of the set of amenities), and a range for each level. The structure is determined by factors like: population structure (age, households, religion), social and economic situation, and spatial situation. The scale and quality of the amenities in an area are determined by the amount of people using the amenity and its frequency. In this respect the relation between the level of the amenities and the reach is important. The higher the level the wider the reach. On the other hand, the higher the frequency of use, the smaller the reach must be. The maximum distance a consumer considers acceptable to reach an amenity depends of the type of amenity, frequency, transport possibilities and subjective perception. The reach of an amenity influences the chosen means of transport. In case the amenity is very near, it can be reached on foot or by bicycle. Further away car or train are needed. This is also related to the category of visitors (old or young) and availability of the means of transport. On the supply side the minimum turnover, necessary for the amenity (for instance a shop) to be profitable is important.

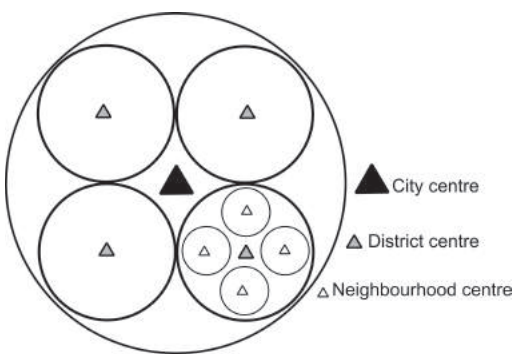
As mentioned before amenities can be divided into ‘compulsory‘ and ‘free’ amenities. In case of ‘compulsory’ amenities (schools, medical care) the need for them can be estimated fairly easy. In the case of “free“ amenities visiting is without obligation, so that estimating the need is more difficult and uncertain. Factors like distance, quality and alternatives play their rôle.

28.4 EXAMPLE: PROGRAMMING OF SHOPPING CENTRES

The retail structure has two characteristics:

a) shops are concentrated in shopping centres;
b) centres are ranked in a hierarchy.

a) Concentration takes place in order to achieve a certain attraction to the shopping centre. The consumer can buy several articles in one trip (one stop shopping) and can compare goods and prices. By combining shops with amenities like restaurants, pubs, post offices, etc., and by designing a promenade with terraces, fountains, an attractive atmosphere can be created. Concentration makes it possible to connect the centre with public transport.



286 Hierarchy and dispersal of shopping centres

b) The shopping centres form a hierarchy (see figure 286) based on classification of goods in several types. This functional hierarchy is an application on structures *within* a city or town of Christallers[b] ‘central place theory’ that explained an *inter*local hierarchy of communities. The functional hierarchy means that each type of shopping centre is specialised in certain types of articles, and has her own market area. In the city centre, with a function for the whole town, durable goods can be bought, and in the smaller centres in the neighbourhoods the frequently purchased articles (by people who live in that neighbourhood). In recent years the hierarchy is adapted by small selling points in fuelling stations (related to traffic) on the level of the neigbourhood, and megastores on the periphery of the town.

The size of the shopping area depends on the number of inhabitants, income level and what part of the income is spent in shops. It also depends on the loss of expenditure from inhabitants who shop in other areas or, on the other hand, the influx of purchasing power from outside town. The orientation of the local purchasing power to the own shopping centres is greater for daily needed articles than for durable goods. A general expectation is that the more amenities there are in an area, the higher the orientation of the purchasing power to that area will be. The orientation of purchasing power depends on the scale used. For example: 20% of

a Guyt, P. (2000) *Voorzieningen, Ruimtelijke Planning Monografie 4*.

b Christaller, W. (1933) *Die zentralen Orte in Süddeutschland: eine ökonomisch-geografische Untersuchung über die Gesetzmässigkeit der Verbreitung und Entwicklung der Siedlungen mit städtischen Funktionen*. English translation: (1966) *Central places in southern Germany.*

the total expenditure of the inhabitants of a neighbourhood is spent in the neighbourhood, 50% in the district and 90% in the town.

The scope of the shopping area is determined by dividing the turnover in a shopping centre by the required turnover per m^2. In order to estimate the turnover of a shopping centre one can use empirical approaches like consumer inquiries, visitors inquiries and retailer inquiries. Each approach has its advantages and disadvantages. It is also possible to use models, like individual choice models (predicting consumer behaviour) and spatial inter-action models by which it is possible to estimate the effect for existing shopping centres when a new shopping centre will be built. Models used in the planning of shopping centres are based on the gravitation model of Newton, in which the reach of a shopping centre is the result of the attraction of that centre and the distance to that centre.

This formula gives the division of expenditure from j to i and k:

$$Kji / Kjk = Bi / Bk \times (djk / dji)^2,$$

In which:

- Kji = amount of expenditure from j orientated on i
- Kjk = amount of expenditure from j orientated on k
- Bi = population of i
- Bk = population of k
- Dji = distance between town j and i
- Djk = distance between town j and k

With respect to shopping centres, the question is how they should be organised and designed. Programming research should give the information needed. Items like acceptable distance between parking place and shopping centre, a good mix of branches, and effective routing, are important for designing a well-organised shopping centre. There is a relationship between the size and type of the shopping centre. Small centres have the form of a strip or a court, big shopping centres are clustered in malls.

Because of some developments, for instance, the diminishing size of a household and changing shopping behaviour (caused by increasing mobility, other preferences, technical developments, teleshopping), the position of the neighbourhood centres changes. Some centres will vanish. It is expected that the shopping structure will become less dense.[a] On the other hand, we see small shops linked to fuelling stations and train stations, related to traffic flows. Because of lack of space in city centres, new types of shopping centres (Large-Scale Retail Establishment) arise at the edge of town (see figure 287). As a result of a more efficient purchasing policy of the shopkeeper, the turnover per m^2 will increase.

28.5 EXAMPLE: PROGRAMMING OF BUSINESSES

The employment in a region or town is strongly influenced by the current economic situation. The structure and composition of the employment changes with economic and technological developments. In contrast to amenities, the programme for businesses in a planned area is not dependent in the first place on the size of the local population, but on the attractiveness of the local area for businesses. It is based on several factors influencing settlement of firms and offices: quality of the location, reputation, acquaintance with the location by businesses, social climate, co-operation of local government and many other factors.[b] In determining the programme not only the preferences of the firms themselves play a rôle but also the wishes of inhabitants (who do not like the hindrance of the adjacent businesses) and local government policy. Because of the variety in potentially relevant factors that may be important for the various types of firms, different types of locations (industrial areas, business parks, office concentrations, small business areas in residential quarters) are discerned

287 Large-Scale Retail Establishment Alexandrium II in Rotterdam North East

BOX 1: Example of determining the amount of parking place for a shopping centre

The required number of parking places depends mainly on the type and area of the shopping centre. The greater the shopping centre, the greater the reach and the greater the number of visitors that travel by car. This example refers to a city centre on Saturday, because then the maximum number is needed.

Area of the shopping centre is 100.000 m^2 floor space (accessible for the visitors) exclusive 50.000 m^2 storage and office space.

The estimated number of visitors on a Saturday is 150.000

Assumption: 1/3 travels by car = 50.000 people.

Assumption: average two persons per car, so 25.000 cars are expected on a Saturday.

The parking time is depending on how long visitors are staying in the shopping centre. This determines the circulation factor, i.e. the average number of cars on a parking place. If this factor is 5, than the number of parking spaces is 5.000.

The visitors are not equally divided over the day, so that an axtra amount of e.g. 1750 places is needed for the period between 13.00 and 16.00, so in total 6.750 places have to be available.

For people working in the shopping centre 1500 places (1 parking place per 100 m^2 space) are needed.

Parking area needed for visitors is

6.750 x 25 m^2 = 168.500 m^2

and for employees 1.500 x 25 m^2 = 37.500 m^2

so that in total206.000 m^2

parking lot have to be planned for the shopping centre.

(The amount of parking spaces per 100 m^2 shopping area can differ with the type of shopping centre).

a Toorn Vrijthoff, W. van der, H. de Jonge et al. (1998) *Werk aan de winkel. De toekomst van de winkelmarkt 1995-2015*.
b Guyt, P. (2000) *Bedrijvigheid, Ruimtelijke planning Monografie 3*.

and developed in cities and towns. Attempts are made to match different types of locations with types of businesses that are possible or desired in the various locations. It can be used in the development of a spatial policy local government wants to pursue. Municipalities also make use of estimations of the future employment, using instruments like models, inquiries, extrapolations and planned goals. The number of workers has to be divided by the number of workers per m^2 to calculate the space needed.

For offices the floor space needed depends particularly on the type of employment in offices and space per employee. The size of the employment in offices depends partly on the size of the local population. But, offices can also be established there because of specific advantages. Important factors are accessibility by car and public transport, parking space, and prestige of location and building. The ground space needed depends on the number of floors, and the ratio of the built and total area (ground-space-index). Example: 5000 employees have to be accommodated. Every person needs 30 m^2, in total 150.000 m^2 floor space. If the number of floors is 10, the built area is 15.000 m^2. If the ground-space-index is 20-100, the ground area is 75.000 m^2. The floor-space-index is 2,0 (150.000 / 75.000).

	Building form	Density	Image	Nearness amenities	Public transport	Attainability by car
1 Office boulevards	h / m	z	++	++	++	+
2 Other centre	m	i		++	++	+
3 Junction locations	l / m	i	+	+	+ / ++	++
4 Offices in neighboorhoods	l	e			+	
5 Offices on industry and harbour sites	l	e				++

h high rise
m middle high
l low

z very high density
i high density
e low density

++ very good
+ good

288 Office locations and characteristics[b]

The relationship between the employment in offices and the floor space needed is variable. When the growth of employment in an office building is absorbed in the existing building, the average space per worker decreases. On the other hand, in case of moving to a larger office building (anticipating future growth of employment) the space per employee will be very high. The interests of the institute that made the prognosis may influence the prognosis of the need for office buildings. Building consultancy agencies are interested in an optimistic view: because they earn more when many buildings are built. On the other hand, real estate consultancy agencies are interested in a pessimistic view: in that case there is more need for their services. Local government stimulates offices in their municipality because offices offer workplaces without pollution, and because certain exploitation problems can be solved, because it is expected that office organisations can pay a high rent. Moreover it is possible to influence the modal split by establishing the offices near public transport stops.[a]

As is the case for businesses in general, offices can also be located on a variety of types of locations. Alongside is an example of distinguished office locations is shown.

28.6 CONCLUDING REMARKS

Programme research can be related to several objects, themes and points of view. These determine which different research activities are relevant. It is recommended to be very critical with respect to the used information as inquiries, statistics and interviews. Uncertainties should not be neglected, but should be met by a flexible design. After execution it is desirable to monitor developments in order to be able to evaluate the programme. Programme research is a continuing activity.

a Guyt, P. (2000) *Kantoren in kort bestek*.
b Gemeente Rotterdam (1999) *Kantorenbeleid 1999-2003*.

29 PROGRAMMING OF BUILDINGS

THEO VAN DER VOORDT
HERMAN VAN WEGEN

A vital function of a building is spatial organisation of activity. Designing must have a sound insight into points of departure objectives and wishes of users: their activities, organisational structure and ensuing spatial consequences. When a new organisation is looking for an adress; or when an existing organisation has decided that present premises are no longer suitable, a lot of thought should be spent on possible and desirable variants of solution. Instances are: remodelling, expansion, disposing of (a part of) the building, joining, moving into another building, or (commissioning the) designing of a new building. In order to ensure that the building supports activities in an adequate way with respect to cultural, aesthetic, economic, climatical, technical and judicial considerations, the requirements must be carefully charted.

This is also mandatory for weighing alternatives against one another and for ascertaining whether wishes and potentials match. It is extremely rare, that what is deemed desirable is completely feasible in terms of time and money as well. Present laws and rules delimit possibilities as well. This necessitates formulating priorities and making choices. Charting requirements, wishes and boundary conditions is termed in the building process ‘programming’; or ‘briefing’.

In this contribution we discuss how programming of buildings is effectuated and identify the means available to trace and record wishes and requirements in a document: the programme of requirements, or brief. These requirements must get the form of a description of the performance to be delivered. They may be of a quantitative or qualitative nature and have regard to location, building, spaces, building parts and facilities.

29.1 PROGRAMMING IN THE BUILDING PROCESS

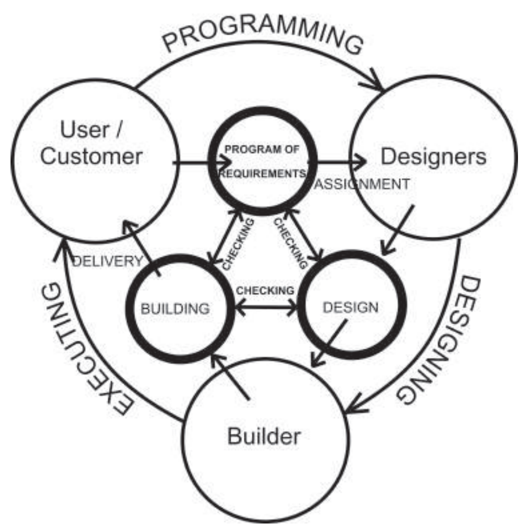
Programming and recording the results in a brief is an essential step towards a well-considered plan development. It will preclude that solutions are embraced too readily who have shown themselves to be adequate elsewhere, but are not tailored to the specific requirements and wishes of the organisation calling the shots. By thinking too early in terms of solutions, this stage of the programming often becomes a weak link in the building process. This sometimes causes that in a later stage, when the solutions proposed have already been discussed, it is nevertheless decided to formulate explicitly the requirements and conditions. Additional work and loss of time goes hand in hand with it. Other objections *vis-à-vis* the slipshod passing of the programming stage and preliminary brief are:

- profitting too little from usage experience;
- the designer must spend a lot of time on collecting and analysing the information;
- the feasibility of the project can only be checked much later; on the basis of the first sketched design;
- the design must be altered more often; and more extensively. This costs time and money; and often irritation for the parties concerned;
- a lack of time and attentiveness for alternative solutions;
- one has to settle for a building more expensive and less appropriate than the one opted for.

29.2 PROGRAMMING, DESIGNING AND BUILDING

Programming, designing and building are three main activities in the building process. The diagram to go with this here gives a systematic view of the place of programming in a traditional building process.[a]

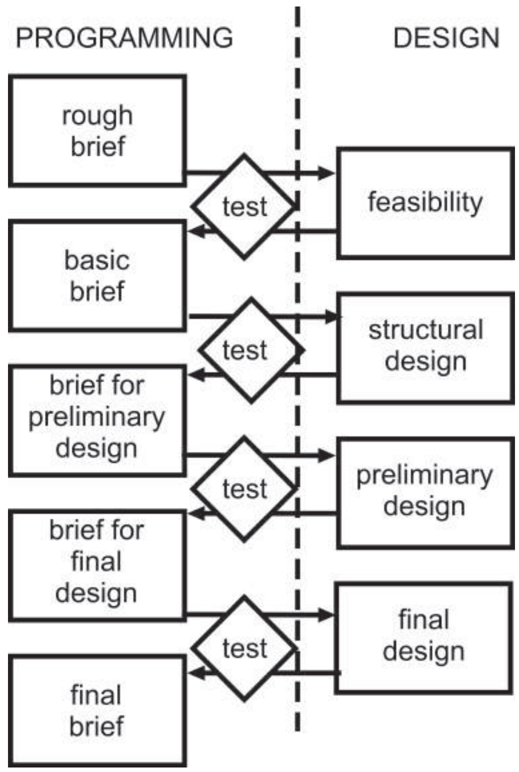
In order to keep the scheme simple, it is pre-supposed that the principal co-incides with the owner and is acting also on behalf of future users of the building. The three parties mentioned are often supported by advisors, sub-contractors and providers; that have been disregarded. The arrows between the products (brief, design, building) indicate that there is



289 Place of programming in a traditional building process

a Derived from Vrielink, D. (1991) *Hoe verder met het prestatieconcept? Kwaliteit maken, meten en vergelijken*.

always – or should be – a reciprocal checking, giving the process a cyclical character. When, for instance, the design does not accommodate the programme, this may be ground on which the design or programme may be adapted. This does not take away from the fact that in traditional building the programming stage is, in principle, closed off by a final brief. Next, the designer picks it up. This approach makes the brief a rather static document. Subsequent detailing concerns primarily technical matters and hardly anymore spatial-functional aspects. Also, in building processes with modern organisational forms like Design and Build, General Contracting, Build Operate Transfer (BOT) and contracting on the basis of a performance contract, the programme of requirements is a rather static document. First, the brief is developed. Next, one party or one building team is responsible for design and realisation. BOT implies that this party also sees (temporarily) to maintenance.



290 Brief developed from global to detailed

An advantage of a distinct programming stage, is separated up to a degree, from the designing stage, so that time and attentiveness is spent explicitly on clear formulation of the requirements, without thinking immediately in terms of solutions. When the result is recorded in a brief, all parties concerned know what they are doing. This is opposed by the fact that translation in images and sketched designs often leads to new forms of insight; and, together with that, to different wishes. A designer can envisage solutions not called for in the programme of requirement, or even opposing it, but which may imply an essential improvement of the plan; for instance by using in the design properties of the environment. The brief may also contain contradictory requirements, or those of a type that can not be accommodated; emerging during the designing process. In this, it is up to the principal to assess differences between programme and design and to accept or reject. It should be added, that delivering information 'just in time' is meeting with increasing demand: more information should not be provided than is needed on that specific moment. That is the reason why the *'Stichting Bouwresearch Rotterdam'* (SBR; *Foundation for Building Research Rotterdam*) makes a plea for a gradual development of requirements, from global to detailed; in combination with plan development.

29.3 CONTENT OF THE BRIEF

In order to give the designer and other parties a sufficient grip on the building process, the programme should be as complete as possible *vis-à-vis* requirements and wishes of the principal and other conditions the building must comply with. As a function of the size of the building and complexity of the task, the number of requirements can grow considerably. It is important, therefore, to order the requirements for surveying purposes. Different ways of categorising are used. We restrict ourselves to categories of the Netherlands Normalisation Institute (NEN 2658, the current 'norm') and the categorising of SBR 258 (often applied in building practice).

29.4 NEN 2658

According to NEN 2658, *'Programmes of requirements for building and matching project procedure'*, a programme of requirements should comprise the parts of boundary conditions, of characteristics of the target group to be housed, and of requirements put to the object. The boundary conditions are relating to the laws and rules applying, technical aspects and financial aspects. The characteristic of the target group(s) to be housed should give an insight, among others, into the objectives of the organisation, the users and their activities and expectations for the future. With regard to the requirements relating to the object, NEN 2658 distinguishes requirements for location, the building as a whole, building parts and facilities on the premises. In addition the project procedure should be recorded. It involves two parts:

- Identification of the project (type of the building, purpose, situating, main sizes and building volume, costs and financing, relevant documents and participants etc.).
- Task description (tasks and responsibilities of the agents concerned), process description and temporal planning.

Various practical guidelines have been developed for filling-in the programme.[a] The lists for controlling and checking provided here are giving a good picture of the subjects on which the programme should shed light. NEN 2658 is less clear on the content of the requirements, the conceptual framework and the phased emerging of requirements.

29.5 SBR 258

Additional study of the conceptual framework and the phased approach was conducted by *Stichting Bouwresearch Rotterdam*. The third edition of SBR 258 *'Programme of requirements. Instrument for quality control'* was published in 1996. Next to a clear explanation of the conceptual framework this publication contains a manual for drawing up the project orientated programmes of requirements. SBR 258 is following a compartmentalisation in 5 blocks:

- Usage requirements
- Functions and performances
- Image expectations
- Internal conditions
- External requirements and conditions.

Ad a. Usage requirements

These are the requirements and wishes regarding (parts of) the housing, resulting from the foreseen usage. A picture should be given of the organisation to be housed in terms of nature, size, organisational structure and patterns of activities, now and in the future.

Ad b. Functions and performances

The characteristics of the organisation to be housed should be translated into spatial-constructive requirements and wishes with regard to the location (ease of access, facilities in the surroundings, possibilities for expansion, etc.) and requirements and wishes with regard to the building. Relevant items are – amongst others – the spatial need for the building as a whole and per room, physical building conditions envisaged (temperature, light, humidity, sound, view), safety and flexibility.

Ad c. Image expectations

Although the creation of visual quality is belonging to the competence of the designer, the principal is well-advised to formulate his own wishes in this respect as clearly as possible. Does he want to have an atmosphere of luxury or one of soberness and effectiveness? Is a traditional style of building assumed, or rather something rubbing shoulders with high tech? Should the building express something of the function or the corporate identity; or exactly the opposite?

Ad d. Internal conditions

This concerns financial-economical conditions (possibilities and limitations with regard to costs of investment and exploitation charges) and conditions relating to time (date of completion, time-frame of the housing process). Other internal conditions are, for instance, specific requirements with respect to sustainability.

Ad e. External requirements and conditions

This concerns requirements as seen from the perspective of spatial ordering and other laws and rules. Examples are functional zone planning, requirements ensuing from a protected urban

a NNI, Nederlands Normalisatie Instituut (1992) *NPR 3405, Programma's van eisen voor gebouwen. Indeling en aspecten van gebouwdelen en voorzieningen op het terrein;* – (1993) *NPR 3401, Programma's van eisen voor gebouwen en bijbehorende projectprocedure, Algemene naloop-lijst*.

view, the Building Decree, security standards, alcohol and food industry law, consumer's law, environmental maintenance, general police ordinance etc.

29.6 KINDS OF REQUIREMENTS

The requirements should really have something to say. Platitudes like "The building should not leak" are to be avoided. In addition the requirements should be formulated clearly in a maximal verifiable manner. An important distinction is the one between functional requirements (or usage requirements) and performance requirements.

Functional requirements describe the intended functioning of the building. They are formulated in a qualitative way; for instance: "the building should be integrally accessible." A variant is the description of the activities to be housed; for instance: "there should be space for placing 12.000 books in an open shelf arrangement, taking in and giving out of books, the reading of books and magazines and consulting reference books."

Performance requirements record the performances that are asked for. It concerns requirements that can be checked objectively. With that in mind the desired quality level needs to be quantified as much as possible. Examples are: "a gross floor surface of 12.500 square metres", or "free width of passing of doors minimally 850 mm." In the example of the library: "a lending room of 180 m^2 with 12.000 books, an in-take and lending desk of 20 m^2 and a reading room with 30 seats of 90 m^2 in total." Performance requirements literally point to what the building should perform.

One should be cautious in formulating descriptive requirements in the form of solutions, like: "the floor should be made of white marble." This formulation is leaving hardly any room for alternative solutions. On the other side it does not make sense to give a description in performance requirements when the commissioner is saying explicitly to accept this specific solution only. However, in many cases a demanded solution is referring to underlying wishes, for instance: "can be cleaned simply and has a luxurious atmosphere." By making the underlying wishes explicit and including them in the brief, a space comes into being for alternative solutions obeying the requirements just as well.

Clients' requirements may relate to different scales, e.g. the total building performance and requirements for different spaces. The latter can be documented per room using so-called activity sheets and performance criteria, including:

- user characteristics: number of users, their functions and personal characteristics (only when these have spatial implications);
- activities (type of activities, time schedule);
- facilities and furniture, temporary or permanent;
- spatial requirements with reference to accessibility, efficiency, ergonomics, spatial orientation and finding your way, privacy, flexibility etc.;
- technical and physical requirements regarding floor load bearing, thermal comfort, acoustics, lighting and fire safety;
- wall finishes, floors and ceiling, regarding aesthetic preferences, ecological issues, maintenance;
- dimensions and square metres, if relevant, both minima and optima;
- number of required areas of this particular type;
- a brief explanation, if required.

29.7 METHODS FOR PROGRAMMING

The most important materials for preparation of a brief are:

a. Accurate documentation and analysis of the organisation and activities for which housing is needed. The necessary information can be collected by interviews with the client, questionnaires, analysis of documents, behavioural mapping, counting occupancy rates, and workshops with prospective users. Scenario techniques can be used to comprehend spatial implications of future developments.

b. 'Translation' of organisational characteristics and functional requirements into performance criteria. This functional analysis is normally based on clients' experiences and the programmer's professional expertise (often a specialised consultant or architect). Additional research is frequently required, especially when new functions are involved. Testing design variants in a computer model, scale model, or full-scale mock-up are techniques often used
c. Site visits to similar projects (reference projects or 'precedents').
d. Analysis and Post-Occupancy Evaluation of similar projects (see the Chapter on ex post evaluation of buildings).
e. Review of literature, searching for data, experiences with particular design solutions, standards, guidelines for programming and design, etc. It is particularly worthwhile to review references of similar building types. Furthermore, general studies on anthropometrics and ergonomics or functional aspects like safety, sustainability and cost-effective design may be extremely useful, both for programming and design

The activities named first are known as 'functional analysis' or 'function analysis'. The translation from function analysis to a functional design is sometimes called functional designing. The methodical approach of this inter-connects with the ergonomic analyses of the American Frederick Taylor. In the sixties and seventies his approach was worked out for architecture by Zweers and De Bruijn and Polak.[a] For a more recent treatment of functional designing we refer to Van Duin *et al.*, Sanoff and Blyth & Worthington.[b] Here we restrict ourselves to a summary of how function analyses are taking place, which literature is especially relevant and how use may be made of reference projects.

Function analysis

Programming starts with analysing the organisation and activities needing housing. The analysis entails determining the nature of the activities and the required spatial condition, like the floor surface needed, possibly minimal sizes for width and depth, physical conditions (lighting, acoustics and such) and spatial-psychological requirements (view, privacy, territoriality). Careful thought should be given to which activities are needing their own, specific space, and which activities may be housed in a common space. Should copying and fax equipment be installed in the space of the secretariat, in a separate space, or in an (open) intermediary room? Is each office getting its own place for discussion, or are there meeting rooms for common use and informal corners for sitting together? When it has been settled which activities need their own space and which activities may be put together, spatial conditions per room can be formulated. This determines to a high degree the spatial need in terms of separate rooms and conditions. By the way: not every activity requires a specific spatial solution. From the perspective of flexibility and future value it is important to design the spaces in such a way, that they can not only serve the activities intended, but other activities as well. A narrowly 'tailored suit' in the form of an unequivocal 1:1 relationship between function and form restricts the possibilities for adapting to changing circumstances.

Activities and spaces with a strong mutual relation should be positioned close to one another, if the situation admits this. Other considerations for spatial proximity or of clustering spaces (zoning) are common characteristics in terms of public / private, hot / cold, silent / noisy, view / inner space, etc. The analysis of spatial relations can be done easily by hand, in the case of simple buildings. For more complex structures using the computer is advisable.

Box 1: Example of a functional analysis of an office restaurant

The required number of square metres depends on the number of people using the restaurant at the same time. Professional literature includes the following guidelines:

- Restaurant: number of seats x 1.4 m^2
- Counter, kitchen, storage space: number of seats x 0.7 m^2
- Staff rooms (cloakroom, informal meeting place during breaks, office space): number of seats x 0.4 m^2.

Data based on client's information and assumptions based on consultant's experience:

- Number of employees: 400
- Number of people actually present: 90% (10% absent for reasons of sick leave, vacation, training etc.)
- People have staggered lunch breaks: from 12.00-12.45 and from 12.45-13.30.
- Assumption: 60% of all employees use the restaurant.
- Assumption: even in peak hours not all seats are loccupied (e.g. 3 persons using a 4-person table). For this reason 15% extra space is required.

These data and assumptions lead to a calculation of the number of seats as

$$\frac{400 \times 0.90 \times 0.60 \times 1.15}{2} = 125$$

and required floor space of:

- Public space	125 x 1.4 m^2 =	175	m^2
- Counter/kitchen	125 x 0.7 m^2 =	87,5	m^2
- Staff	125 x 0.4 m^2 =	50	m^2
- *Total*		*313*	*m^2*

a Zweers, B.H.H. and W.N. de Bruin (1958) *Een analytische methode voor het ontwerpen van bedrijfsgebouwen;* Polak, B. M. (1973) *Functioneel ontwerpen*.

b Duin, L van, W. Wilms Floet et al. (1989) *Functioneel ontwerpen, ontwikkeling en toepassingen van het doelmatigheidsbeginsel in de architectuur;* Sanoff, H. (1992) *Integrating programming, evaluation and participation in design;* Blyth, A. and J. Worthington (2001) *Managing the brief for better design*.

Relevant tools and literature

Obviously, principal and programme advisor will use their experience(s) with their own organisation and with drawing up programmes of requirements. Programme consultants are often making use of a brief used before, for a comparable task; while going through it with the client, or without him, and adapt it to the present task. For auditing the organisation use is made of interviews, workshops with (representatives of) users, ratios of usage, scenario techniques, and sometimes also space planning studies in a 1 : 1 model. Many things do not need new thought. During the years many publications have appeared that may support a function analysis and that may be useful for formulating internal and external conditions. Without trying to be comprehensive, we mention just a few important publications:

- Studies specifically aiming at the development of a brief; among them SBR 258 and the booklet 'Bouwstenen voor het PVE (Wijk and Spekking) and the publications of Preiser *et al.*, Preiser, Sanoff and Blyth & Worthington.[a]
- Space planning studies translating the activities in spatial measures, like *'Architects' Data'*, the English translation of Ernst Neufert's *'Bauentwurfslehre'*.[b]
- Studies of buildings for a specific kind of function(s), e.g. books focussing on office buildings, libraries, schools or hospitals.
- Studies of specific aspects like:
  - Integral accessibility, social security
  - Flexibility
  - Sick Building Syndrome, sustainability
- Norms and directives, such as NEN 1824, Ergonomic recommendations for sizing office rooms.
- Branch-specific building norms and design directives. Hospitals, for instance, must comply with the building norms of the College for Hospital Facilities. For schools, homes for children and libraries norms and directives have been developed as well.
- Surveys of law and rule giving.

Reference projects ('precedents')

Buildings with identical or comparable function(s) may teach a lot. It is wise, therefore, to visit kindred buildings to get *'in situ'* new ideas by observing and discussing for one's own housing. Documentation on buildings and especially evaluations of buildings in stages of use and maintenance are extremely valuable as well. This kind of evaluation is sometimes termed 'Post-Occupancy Evaluation' (POE). When the evaluation is also extending to other aspects than just use and experiencing – for instance to costs, technology, aesthetics – the term may be (Total) Building Performance Evaluation (BPE). For a working out of that notion see the contribution by Van der Voordt and Van Wegen on evaluating study ex post.

Evaluative studies are gaining power when characteristics and experiences from a sequence of kindred building are compared.[c] Comparative building analysis has the advantage over traditional methods of study like observation and interviews, that the information is linked to spatial variants of solution. Each building is the result of a complicated decision forming process, in which points of departure and objectives are translated into an organisational structure and activities and are receiving form in blueprints, floor plans, cross-sections, materials and facilities. Analysis ex post is enabling that thoughts, ideas and points of departure can be rediscovered after the various choices. Obviously, problems of interpretation may result from this; for the design realised has always been influenced by interpretation of the designer and by internal and external boundary conditions; as there are the available budget, and characteristics of the location (functional destination plan, size and shape of the plot, surrounding functions e.t.q.). By the same token, it is desirable to complement the analyses with study of the realisation process, interviews with the commissioner (at the time) and other parties involved in the building process; for instance the architect and advisors. The combination of a com-

a Sanoff, H. (1977) *Methods of architectural programming;* Preiser, W.F.E., J.C. Vischer et al. (1991) *Design intervention, toward a more humane architecture;* Sanoff, H. (1991) *Visual research methods in design;* Preiser, W.F.E. (1993) *Professional practice in facility programming;* Wijk, M. and D. Spekkink (1998) *Bouwstenen voor het PVE, SBR 421;* Blyth, A. and J. Worthington (2001) *Managing the brief for better design*.

b Neufert, E. (2000) *Architects' data*.

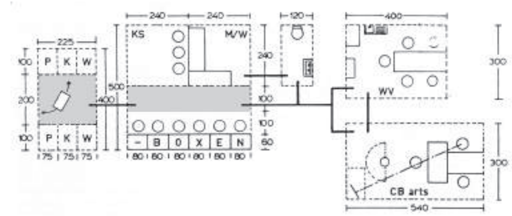
c Voordt, D.J.M. van der, D. Vrielink et al. (1998) *Comparative floorplan-analysis in programming and design*.

parative analysis of buildings with evaluative study may lead to a reasoned typology of solution variants; together with pros and cons for costs and quality.

An example of programming study using evaluative study, is the one concerning health centres by Van Hoogdalem *et al.*[a] These are co-operative organisations, in which one or more general medical practitioners, neighbourhood nursing, social workers and often also physiotherapists have been housed under a single roof. The study aimed at the development of directives for programming and design to be employed in the case of new initiatives. In addition the study was conducted to check the Accommodation Policy Neighbourhood Health Centres at the time and adjust them; especially with an eye on the floor surface needed per discipline, and in total. Beside four case studies, some fifty purpose-built health centres were inspected and subjected to a comparative floor-plan analysis. The analyses were supported by means of one or two interviews and a short questionnaire in writing among daily users (both staff and patients). By way of illustration, we give an example of the programmatic data for an infant welfare centre, respectively a flow-chart for the course of the activities and an picture of the supports of the space.

29.8 CONCLUDING REMARKS

Nowadays a large number of references are available in order to support the briefing process. Apart from the Dutch NEN-standards and the SBR 258 report, English references are mentioned in this Chapter. It should be understood that a brief must not be too restrictive regarding the form of the building. Besides functional requirements, many other aspects will affect the form, e.g. personal preferences of designer and client, contextual aspects like physical, cultural and historical characteristics of the environment, flexibility with reference to changing functions in the future, economic aspects and legislation. It is still the task of the designer to work on a synthesis of function, form and construction, according to the old Vitruvian triad. Modern multi-media techniques and virtual reality will also improve opportunities to discuss formal aspects with prospective users. It is a challenge for designers and their clients to include such new information and communication techniques both in briefing and in design processes.



291 Supports of space for a child health assessment new style

Legend: P K W = storage of prams
CB = doctor
WV = nurse
MW = measuring of length and weight
Boxen = boxes to (un)dress babies

Activity	Time / duration	Room
Parent arrives with child in pram	According to appointment, e.g. 1 child / 20 min.	Via entrance of the health centre or entrance of the nursing service
Parent parks pram	pm	Collective waiting room of the health centre, waiting room of the nursing service, or changing room.
Waiting (if changing room is full)	pm	Idem
Parent takes child out of the pram, undresses it and waits	10 min	Changing room with playpen or prams
Measuring and weighing child + keeping accounts	5 min	Changing room or room district nurse
Consult district nurse	20 min	Room district nurse
Possibly: consult doctor child health centre	20 min	Room doctor child health centre
Parent dresses child	10 min	Changing room
Parent lays child in pram	pm	Waiting room
Parent leaves	pm	Via exit of the health centre or the exit of the nursing service

292 Example of a flow-chart for a child health centre

a Hoogdalem, H, D.J.M. van der Voordt et al. (1985) *Bouwen aan gezondheidscentra. Functionele grondslagen voor programma en ontwerp.*

30 PROGRAMMING BUILDING CONSTRUCTION

MICK EEKHOUT
YPE CUPERUS

Planning the construction of a building includes specification of its technical performance. In the perspective of preceding Chapters on urban planning and planning of buildings, a conceptual range based on sizes from large to small is suggested for the benefit of the overall picture in this book. This will not occur in reality, however, as the time cycles of these scales are quite different. Although the scale range from urban design, architecture to interior design may be suitable in terms of scale and dimension from the point of view of the architect, the range urban design, architecture, and building construction is more suitable in terms of technical function. It defines the phases in terms of time rather than of significance: after the functional and spatial design concept the construction concept is made and developed towards a mature composition which is the construction of the building, as a totality of systems, sub-systems and building parts, components and elements. Materialising a design concept is as significant as the previous conceptual design activities. Building technical design is the subject of this Chapter. Hence, it does not include areas of urban technology like civil engineering: road and water works and infrastructure: like pipes and cabling that make a city function.

30.1 CONSTRUCTION PLANNING ON FOUR DIFFERENT SCALES

Construction planning can occur on four major levels. In the case of specifications for a highway it can be required that a bridge has to be realised crossing a waterway. The specifications will describe the frequency and loads of the traffic, the free spans and the free height underneath for nautical traffic. In case of the second level of a building the planning description will depart from the spatial design concept and the zones in which the construction has to be fitted in in order to form the materialised concept of the building. On the third level, the construction components, of which a lot of different versions have to be developed within one single building, are planned, departing from the function of the desired component within the whole of the building or one of the composing building parts. On the fourth level, the choice of material and production method is made in order to form, out of material or half products, new elements with distinct desired characteristics.

Imagine a building where the load bearing structure has the form of a skeleton and the façade is planned to be produced independently in an off-site factory. In order to keep options open to cater for future decisions; the façade construction could be connected to the supporting main construction with steel angle brackets. Once the façade design is ready and the weight and loadings on the façade are known, the dimensions of the elements of the façade can be developed and engineered and the optimum connection fixed, keeping in mind the mode of elevations and installation. This connection detail might contain steel clad plates and sliding provisions and fixing elements as M16 bolts, which have to be detailed at a scale of 1:1.

30.2 HIERARCHY

These examples illustrate that construction planning is not related to one particular scale. Rather the subject, in the order of given function and 3D form from the previous higher level, like the form of the building has been derived from the town planning design, the form of the construction design of the building is derived from the architectural design of the building. It involves analysis of the technical functions of the higher entity as the higher level into its composing parts. After analysis the appropriate structural scheme has to be chosen, the proper materials, the form of components and elements in conjunction with production and the final detailing fit for installation, each at its own level. The complexity of the building is usually greater than that of infrastructural works. The speciality of bridge design usually refers to civil technology designers and engineers. Infrastructure design, building design, component design and material design are the four basic levels of construction design a planning can be made for.

Decisions about infrastructure belong to a level, different from decisions about the load-bearing construction of a building. However, while there is a separate relationship between the two, it is a relationship of hierarchy. The position of the building depends on infrastructure; not the other way around. The load-bearing construction, in turn, creates the condition for possible claddings. In addition, the cladding component determines the parameters for developing a new material in order to cope with new requirements. This hierarchy of entity and parts co-incides in general with corresponding levels of decision making.

There is also a relationship with life-span. The position of the street, part of the infra-structure and town planning, is fixed for hundreds of years. The building is written off in an economical life of some thirty years and has an average technical life span of fifty to hundred years. The cladding has a technical life span of twenty to thirty years and a market lifespan possibly shorter. Dwellers move every 7 to 10 years and office buildings are re-furbished every 5 to 10 years; shop interiors every 3 years.

The hierarchy of building parts reflects the ease with which elements can be moved. A user can move furniture immediately, since it can be lifted, not being connected to other parts. However, designing furniture is not regarded as belonging to the architecture domain. Doors and windows can be swayed instantly; internal partitions as well, if necessary. This is technically more complicated, but a professional craftsman can remount an internal wall within one single day. Alterations to the load bearing structure are technically major changes that are hardly done within a period of one generation of habitation (10-20 years for offices and 30 years for housing). Altering the position of a street is beyond consideration; planning new roads takes decades. Understanding different levels of building parts, and their consequent levels of decision making (reflected in life spans and mobility) is important in determining the technical performance specification.[a]

30.3 DISCIPLINES

If we look at a building as a system, 'a group or combination of inter-related, inter-dependent, or inter-acting elements, forming a collective entity'[b], we can also define the sub-systems. The load bearing structure is a sub-system to the building that received external loadings and sustains dead weight and directs them as internal forces to the foundation and the soil. The plumbing sub-system takes care of distribution of water throughout the building. The building façade sub-system provides the climate barrier between inside and outside. Many more sub-systems can be identified this way. These sub-systems are called building parts. These technical sub-systems may co-incide with one level of decision-making. The sub-system 'furniture' co-incides with the authority of the space user while the sub-system 'internal-partitions' with the authority of the tenant. In contrast, the plumbing sub-system depends on decision-making at all levels. This requires an integrated and coherent chain of decision making from source to tap.

A much more strongly relationship is seen between sub-systems/building parts and the building disciplines concerned. The main contractor sub-contracts laying the foundation to a third party, specialising in driving piles. Another sub-contractor builds the ground floor, while yet another party builds the steel or pre-fabricated reinforced concrete load-bearing structure. When planning the construction process, all specialised producers working off-site and all disciplines on the site need to be considered. They should not interfere with one another, nor should they damage each other's work and they should be able to finish their job, if possible, in one un-interrupted working period. A building built and completed on the site through a

a Habraken, N.J. (1982) *Transformations of the site*.
b Hanks, P. (1988) *The Collins concise dictionary of the English language*.

well co-ordinated building process has the potential to be built and maintained by independent disciplines and to adapt to new demands. Consequently knowledge of the construction process is essential when writing the technical brief.

30.4 BUILDING AND MANUFACTURING

Building is an on-site assembly and installation process as productions and manufacturing are factory-based pre-processes. On-site building processes exposed to the outdoor climate, are usually unique and quality can be controlled mainly on-site during construction. The elements and components produced off-site an be controlled in quality as end products in the respective factories, or as a result of a continuous and total quality assurance process. On site only the installation aspect is controlled. Building elements and components of diverse natures and their mutual (i.e. external) and their internal sub-system connections are subject to ever increasing quality demands. The two contemporary examples of a traditional timber window frame in a dual brick wall in a rural type building with a triple-glazed, climate-controlled façade integrated with an air-conditioning system in a high-tech office building illustrates the way in which an increasing part of the building energy is transferred into production environments. The development costs of high-tech systems for the said triple glazed façades cannot be justified for a single building. Manufacturers who intend to recover their investment over a period of time incur such costs. The shift from 'building' to 'production' and 'manufacturing' creates an appropriate environment for development of project-independent designed, but project-pre-fabricated sub-system elements and components. At one extreme the whole building could be pre-fabricated in different factories of co-makers and finally assembled and completed in a single end-line factory. The leading example of this is the Japanese Sekisui Heim house.

293 Sekisui Heim, housing factory in Japan

From a limited catalogue range of components, the client can design his house, as he would purchase a modern kitchen. All parts are assembled in the end-line factory into three-dimensional elements designed to fit onto the back of a truck. These are then transported in the right order to the building site, where they are post-assembled to form the final house.[a] An on-site assembly process replaces the traditional construction process, however, since building is by its nature always site related – unlike cars and other consumer products – it will keep to some extent the properties of an on-site 'building' process. (In the fourties one of Jean Prouvé's very mobile and light-weight houses was stolen from the site!) Understanding the turning point in balance between building and productions & manufacturing is a very important factor in planning construction.

30.5 BUILDING CONSTRUCTION PLANNING

The specifications of the technical composition of a building are described by the architect in the project specifications. These specifications contain:

- an administrative part;
- a technical description part;
- and a building execution part.

This type of project specification stems from the traditional habit in the building industry to describe and understand traditional methods of building using traditional materials. Both designer, the architect, as well as building contractor mastered these techniques and materials. Communication was simple; quality assurance based on the fact that many influences on quality could be managed and checked on the site itself.

However, with the introduction of pre-fabrication and industrialisation in the building process, with their inherent specialised production techniques by the producer, not to be influenced by consumers, it has no sense to prescribe to the specialist, who knows better than the consumer how to make his products. There are only two ways out: to prescribe in global

a Cuperus, Y.J. (2000) *Industrialisatie van de Japanse woningbouw.*

terms the requirements posed to the specific building products, building system; to opt for special components, so that the proposing sub-contractor / producer can detail his proposition and price it. The second possibility is to use the product description of the specialised producer directly in specifications. This is a pure case of ignorance of the prescribing parties compared with the tendering parties; and will happen as long as producers are ahead of architects. In fact, these producers are treated as co-designers and co-producers; and just to fit them in the conventional building and contracting process these specialised specifications are used to enlarge the project specifications.

The project specifications are usually described in the old fashioned manner of collections of materials. It goes far beyond the goal of the site contractor to divide the total job of productions off-site and building on-site and its respective technical description into workable parts, i.e. building parts that are clusters of coherent products, with its own administative, production and site assembly conditions. Sub-division of the main contractor's job into 20 to 60 sub-contractors per project contract is a tedious job, with many risks of non-description of the mutual border zones between contractors and mis-understanding of the specialities of these sub-contractors / specialised installing producers. With an increasing amount of specialised contractors in contemporary projects, specialised sub-contracts have to be drafted in order to maintain the quality of the offered sub-contracts. The other *modus operandi* is to pick the brains of these specialists and to describe the specifications from the perspective of the prescribing architect.

30.6 THREE MAJOR TYPES OF BUILDING PRODUCTS

For manufactured products a scale of project independence can be identified in three major types of building products:

- Special building components, are designed and produced for one specific project (designed and produced project–dependent);
- System products or building systems (semi- dependent: designed project independent, yet produced project- related);
- Standard building products (designed and produced project–independent).

30.7 SPECIAL BUILDING COMPONENTS

These are products specially developed for a single building. The building designer or architect designs the global conditions of function, size and spacing and writes their specifications. These have to fit within the entire technical composition of the building and have to give the building that extra flavour or dimension that makes all the special effort necessary. The architect can select a component developer in his own office to work out the special product or select a producer with an experienced precomponent designer/developer in his service. Usually the architect acts as principal, within the budget limits of his client, towards the component designer to fully develop the design of the speciual components, to have a prototype made and after satisfactorally development to have them produced. The entire development process of special building components knows three major phases:

- concept design
- protoytype & testing
- production and installation

30.8 SYSTEM PRODUCTS OR BUILDING SYSTEMS

The brief is not limited to one component; rather it covers a family of related elements and components of a building system or sub-system. This can be developed from a special commission related to one specific building originating from the specific requirements of an architect, desiring a project-related sub-system. But, it can also be developed project- independent by a producer as the largest common denominator of a great many different applications with similar or slightly different requirements, which cannot be fulfilled by an existing system, unless the development is started because of a ‘me too’ attitude. In the latter case of a market (sub)system it makes sense to start with market research in order to determine the gross list of demand requirements and market opportunities corresponding with them. From this analysis a development brief can be drafted and the desired performance of the new (sub-)system specified. The preliminary design of the new system can then be checked against this initial specified performance.

Project-dependent systems are developed between an architect and a producer or system developer for use in one project only. Project-independent systems need to be marketed and sold as applications to the clients: the set of all architect / contractor combinations of the different application projects.

Once a detailed and final brief has been developed by the architect, the system developing and producing manufacturer can price his special sub-system for the project at hand. The phasing of the development of system products happens esentially on two different levels: initially, on the system level, afterwards on the application level:

- system design concept
- preliminary marketing investigation
- prototype and testing of system

and

- application design
- prototype & testing of application
- production of application.

30.9 STANDARD BUILDING PRODUCTS

In this case the producer takes the initiative to develop a standard product, totally project independent. It is made for the market, not for specific building projects. Five main phases of development activities can be identified after the initiative or basis for a product idea, initiated either by the marketing department of the producer or by the board:

- concept design
- preliminary market investigation
- prototype and testing
- final marketing investigation
- market introduction & production.

Between, or better still, parallel to the technical phases, the market demand for the developing product is monitored. During the preliminary market research the product concept is presented, the feedback evaluated, and used to modify the design of the final product. During the final market investigation the same is done with the real size prototype. The reactions of the chosen clients (representing the entire market in all of its expected facets) will influence the final composition and appearance of this standard product. One of their characteristics as compared to system products is that they are developed and produced before sales.[a]

30.10 NEW MATERIAL PLANNING: ZAPPI

Zappi represents the ultimate in the new and unknown. The term Zappi was invented by the former town architect of Haarlem, Thijs Asselbergs, at a forum discussion in January 1992. We were asked to describe an ideal building material as yet unknown to either of us. After discussion the term Zappi lived on as special epithet. Originally launched as a term for a new building material with superior qualities yet to be developed, it symbolises the adventurous quest. It represents what is unknown, mysterious, challenging! It is both a material and an

a Eekhout, A.C.J.M. (1997) *POPO of ontwerpen voor bouwproducten en bouwcomponenten*.

idea, simultaneously tangible and abstract. It is a mental construct that cares little about the apparent senselessness of ideas, or practicality of invention.

Firstly: Zappi as it began: a long-term fundamental research project with the objective of the development of a strong, stiff and tough glass-like engineering material that does not fail suddenly on overloading; being carried out in conjunction with the Faculties of Aerospace Engineering and Applied Sciences (materials science programme).

Secondly: Zappi represents not only objectives, but also a mentality. Zappi is a friendly and rather comical bulldog, with a character combining intelligence and perseverance. This mentality is needed to generate the motivation needed to maintain the process of design research, evaluation and development. And who is best suited to the research for this new product? An individual has as many disadvantages as a team. An individual needs a soundboard and subservient assistence; a team can choke creativity of its members.

Looking for Zappi may take a lifetime. The process of design, manufacture and construction usually gives more satisfaction than the void experienced after a building has been completed or a new product has been manufactured and launched. The ultimate goal represented by Zappi may, like the horizon, always remain just one day ahead; but it is, nonetheless, just as noble a goal as the Holy Grail to King Arthur's Knights of the Round Table.

Thirdly: Zappi is always near by. Each step towards Zappi is also Zappi itself, simply because of the pleasure one can derive from achieving a definitive step on the road towards Zappi. An example of such a step forward is the frameless glazing of the early nineties. Each further development towards a perfect structural glass material is also part of Zappi. Each result is achieved because Zappi takes immediate advantage of every new opportunity, although at the same time it never forgets that achievement of the ultimate objectives involves a number of discrete steps. That is the reason why this paragraph contains Zappi in its title: its publication marks one step that has been taken, to be followed, hopefully, by many other equally successful steps.

Fourthly: Zappi represents the infectiousness inherent to development of new products for the building industry. Zappi wants to see the entire audience laughing with it at its jokes, to win applause with its clever feats, and to stimulate the larger circle of parties actually involved – all those who, in one way or another, are engaged in product development for the building industry. This is achieved by disseminating new ideas and products among professionals with the motivation to upgrade the technology of materials and products for architecture and the builing industry. Zappi's answer to the question *"Would you ever do it again?"* would always be *"Yes!"*.

A proposal has been drawn up now for the fundamental materials research required for Zappi, one of Zappi's objectives. However, information about the initiative has already been published – and the pull effect of marketing has resulted in the first collaborations.

Zappi, designing a material

The concept of designed materials is new to materials science. Traditionally, a new material was developed, and then it was up to designers and engineers to find ways to use it. The modern discipline of materials science has made it possible to design materials that are tailored to the demands of designers and engineers. The materials science research constituent of Zappi is an experiment in the design of a material that satisfies the requirements of the architect needing a combination of the mechanical properties of steel and the transparancy of glass.

Glass in architecture

For centuries glass has been used as a transparent barrier to preserve the interior climate of a building whilst allowing daylight in its interior. Experience has shown that it is the most stable transparent façade material available. However, glass has poor mechanical properties. This has resulted in a material conflict. The glass window, essential for the inhabitation of interior spaces, is, in structural terms, just a hole in a wall. From the beginning of this century onwards large glazed openings played a major rôle in the development of Modern Architecture. Glass was used in the construction of tall buildings as a façade cladding for steel or concrete framework structures. Increasingly stringent requirements from the sixties onwards created a need for the enhanced performance provided by the use of coatings and advanced double-glazing systems. In the last decade the use of ultra-transparent glass façades and roofs to contrast with closed walls has become an accepted architectural practice. Yet, glass remains mechanically unreliable. In modern applications glass panels are fully pre-stressed to allow them to bear greater stresses. Although special laminates are available, they do not offer significant improvement on glass as a structural material.

The design of the Zappi material

In essence Zappi should combine the following properties:

- The mechanical properties of steel
- The transparency of glass

In physical terms, an impossible combination in one single material; the first property requires the dense metallic crystalline structure of a metal, whilst the second property requires the microstructure of an amorphous solid mutually exclusive structures.

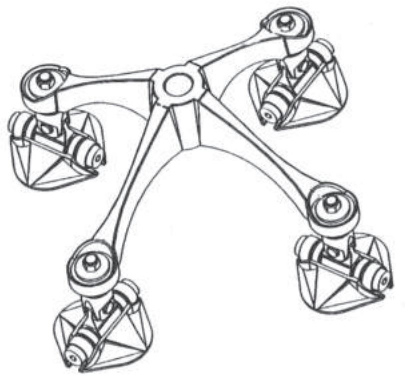
Some answers to the problem can be obtained by combining existing materials and techniques in novel ways. What we have at our disposal are transparent materials like glass and polymers. Pre-stressed glass possesses the required strength and E-modulus, whilst polymers like polycarbonates have the required ductility. The combination of these materials in a composite should provide us with a structural material with enhanced properties in comparison with its components. Obstacles remain:

- Pre-stressed glass fails as a result of extensive unstable crack growth with multi-directional crack branching, leading to total de-cohesion of the material after global or local overloading.
- Amorphous polymers like polycarbonates have very low surface energy values, rendering them highly unsuitable for conventional laminating processes.

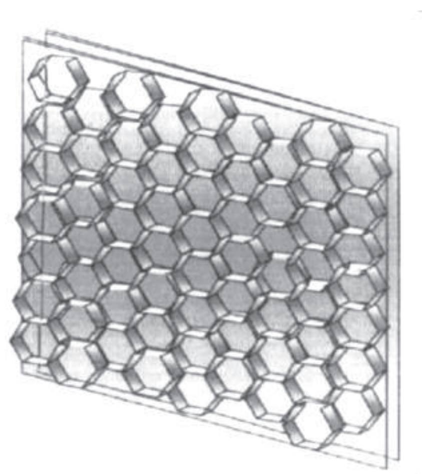
If we are to make a suitable composite then, the cracking behaviour of glass will first need to be modified in such a way that the glass will fail in a controlled manner. Next, we have to bond this modified glass to a suitable polymer.

There are several possible approaches that can be used to modify glass. The most logical approach would be to develop a new glass ‘alloy’ with the required properties. However, development of a new type of glass is a complicated process, requiring extensive technical facilities. Another approach is to modify the fracture behaviour of existing types of glass, to be achieved with exisiting surface modification techniques. The further development of these techniques for standard glass may not provide an optimum solution, but will result in a demonstration of the technology. Two years of preliminary research have resulted in a scientifically-verified concept for a material that combines transparancy of glass with mechanical properties of aluminium.

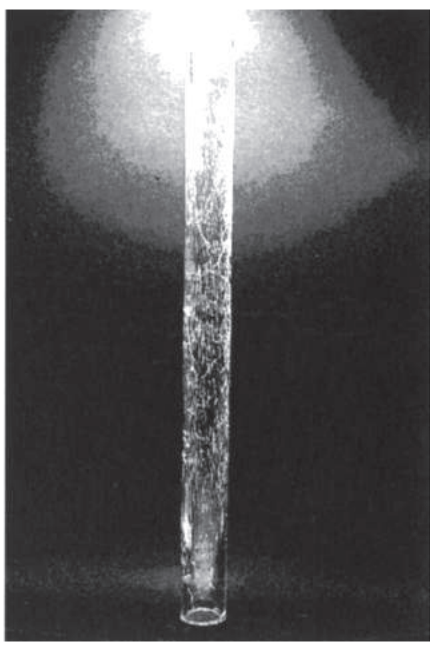
Although Zappi is still a long way off, the research and development programme is an exciting and convincing process. What is so stimulating is that the various projects make it possible to achieve *incremental* results. Factors of major importance for each incremental result are its orientation to constructional value and its practical application. Zappi prefers its high-tech product to be used in good buildings – which makes it even better. This means that the significance of the development of a new product cannot be assessed on its own. As always



294 Hinged nodal bond



295 Design of material with a high acoustic impedance



296 The transparent column after the trial

in research and development, real satisfaction is derived from victories you win by the skin of your teeth. Perhaps, the best remedy for the disease of sterile architecture is joy in design, joy in performance, vigour and wit.

The nodal bond, Barbara van Gelder

Connections between glass and metal have always been a problem. One possibility is to drill holes in the glass, then harden it. Subsequently, bolts are passed through the holes to attach the glass. However, this is not always desirable with modern double glazing panels as it may cause leakages in the air cavity, with all the concomitant problems. One alternative is to bond the double glazing panels to the metal: a new technology, about which relatively little is known at present. Barbara van Gelder carried out research into glass-metal bonded joints, and came to the conclusion that one of the greatest problems involved is the rigidity of the joint, that caused substantial localised forces in the glass and ultimately fractures adjacent to the bond. In order to solve the problem she designed a hinged nodal bond preventing the build-up of excessive forces in the glass. That results in a safer construction. A patent application has been submitted.

The sound-absorbent panel, Kees van Kranenburg

Existing glass structures often exhibit major deficiencies in terms of building physics. The glass construction increases the architectural expression of the building at the expense of the comfort it provides. One problem is noise. A large glass façade possesses only limited sound-absorbent properties which is not beneficial for the comfort in the rooms behind it. Kees van Kranenburg accepted the challenge to design a panel that had good structural properties and was transparent, but possessed much improved sound-absorbent properties. A long period of research into the acoustic poperties of the Zappi panel was required, followed by a series of designs and construction and testing of the prototypes.

The transparent column, Joost Pastunink

The column is a basic element in framework structures. In the past, glass columns were used only extremely rarely, as their inherent brittleness makes them unsuitable for construction purposes. A transparent column capable of transferring invisible vertical forces would offer unprecedented opportunities. Joost Pastunink laid the foundations for this type of column: by designing a process to make a laminate using two concentric glass cylinders he was able to manufacture a prototype that did not fail spontaneously when subjected to an overload, but gradually crumbled in safety under the load imposed. Even after a considerable amount of fracturing the column still exhibited a substantial residual load-bearing capacity. The total load-bearing capacity of a column 40 mm in diametre and with a wall thickness of 3 mm is 10 tonnes – equivalent to a roof surface of 100 m^2, including its own weight and the useful load. A patent application has been submitted.

30.11BUILDING TECHNICAL PROGRAMMING

Planning the production of building components may be characterised as an ex ante activity; it precedes the conception of a building design. However, even while a component is being planned, performance and market assessments are continuously evaluated, independent of construction activity. This is very much ex post, measuring product performance in its designed environment.

In the final analysis, construction of buildings can only be planned with full appreciation of construction processes and details.

31 DESIGNING A CITY HALL

CAREL WEEBER
JOB VAN ELDIJK
LENNEKE VAN KAN

31.1 INTRODUCTION

This is the report of a design process of Carel Weeber for a new City Hall in the town of Berkel en Rodenrijs. Each illustration indicates an important step in the design process.

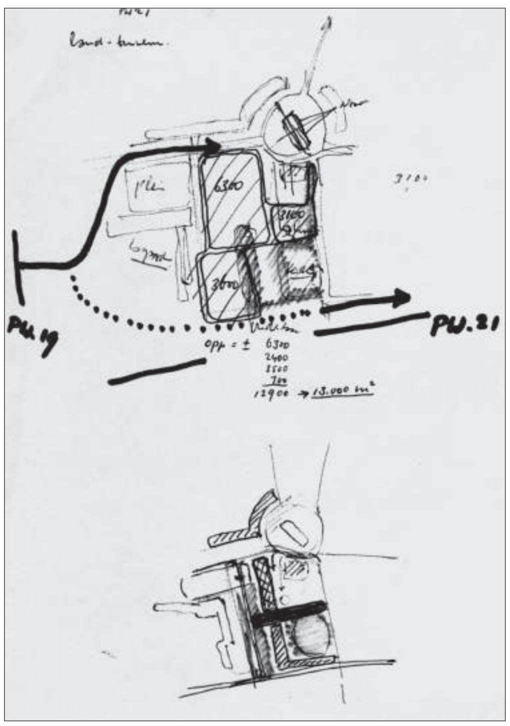
In my design process, the working out of associations and design ideas is taking place in my head, in my memory. This may be done everywhere, at any time. I investigate an idea like that in small sketches. As I grow older, I need fewer sketches. Now that I am working exclusively on the computer, these sketches are at the same time the start of a process of elaboration. Previously, I started with a drawing in ink in the top-left corner; a few days later I would finish in the corner right-below. If that did not come off very well, I started anew. I was taught to do so at Delft University of Technology and, basically, this is still the way I work.

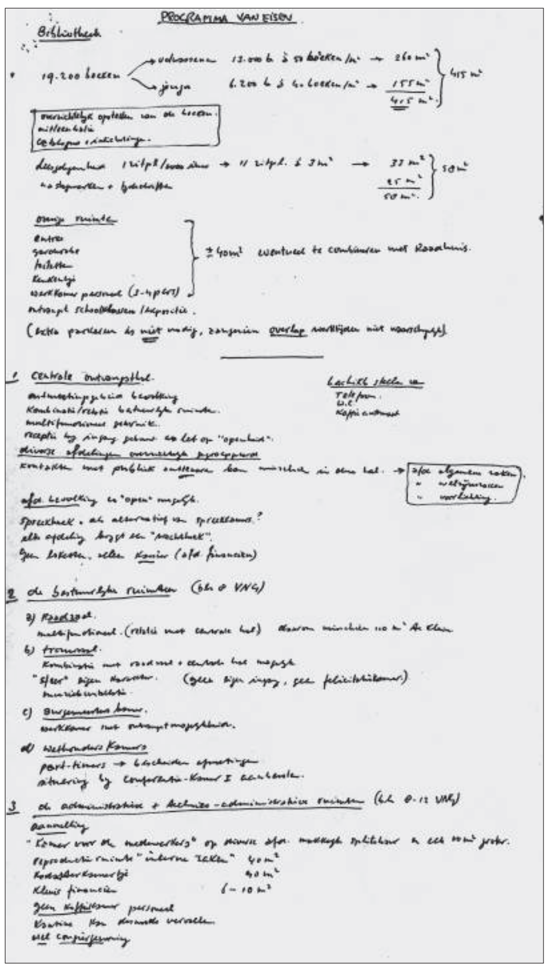
The commission described consisted in a Prize Competition on the basis of invitation for a new city hall in Berkel en Rodenrijs. My design process started with an extensive study of the location and the programme of requirements. Next I tend to ponder the possible and required spatial relations between functions, while trying to develop a total concept. I am studying scale relations, placing the whole in the context in terms of urban architecture, starting with floor plans, cross-sections and the front. I am making spatial sketches while studying new design ideas. In the end I make the final design drawings. Visually the deployment of my design process looks as follows.

31.2 DESIGN PROCESS

297 Study of context

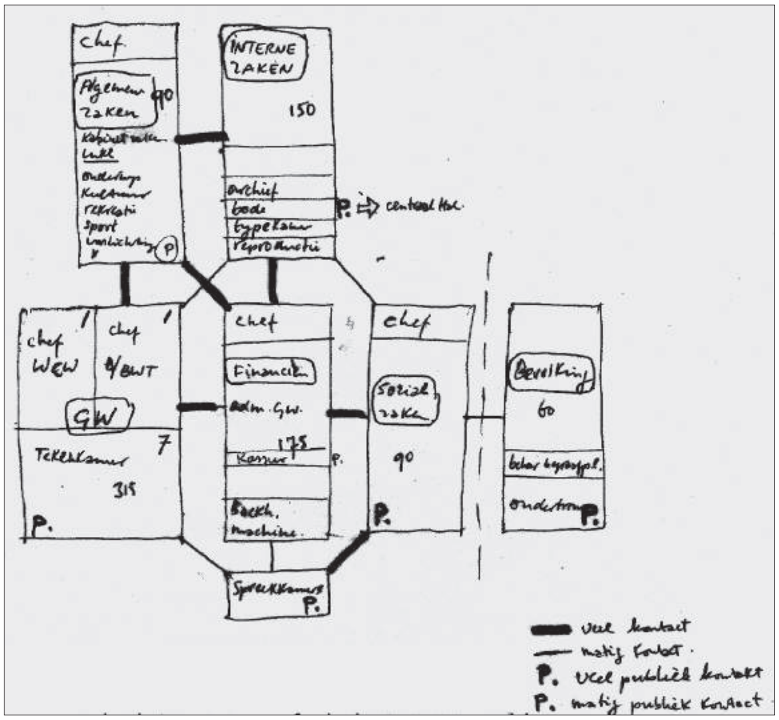
As the first study the context in terms of urban architecture





298 Summary programme of requirements

Along with the situation I study the programme of requirements extensively. I always make a summary of it; I am already learning it by heart.

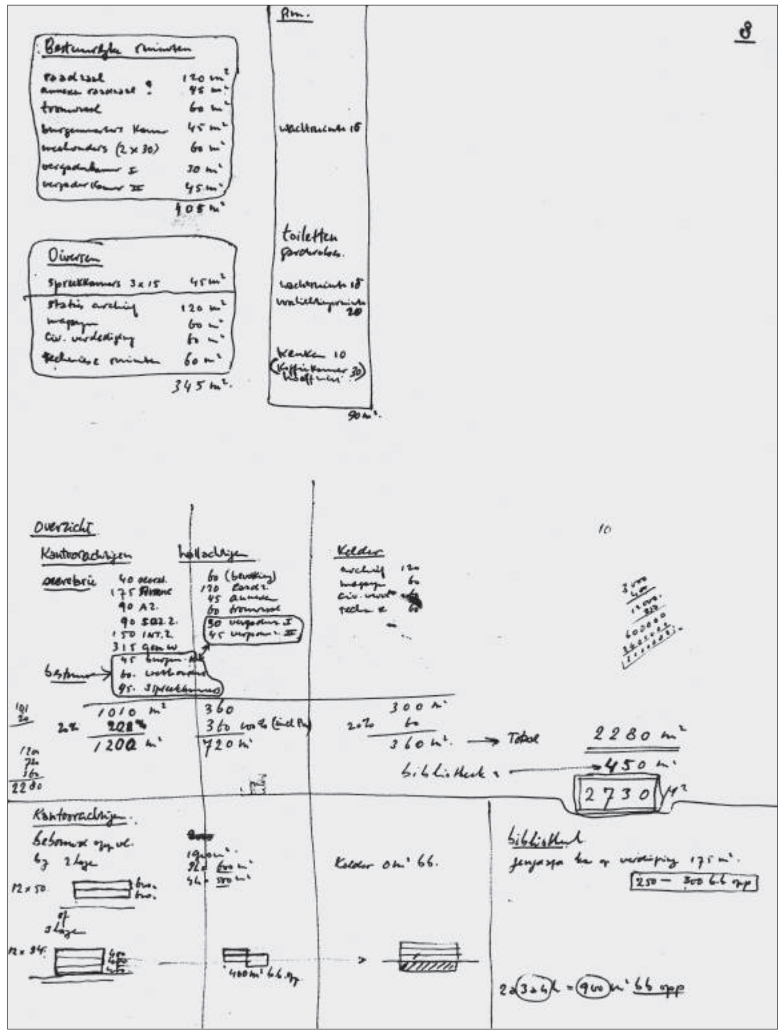


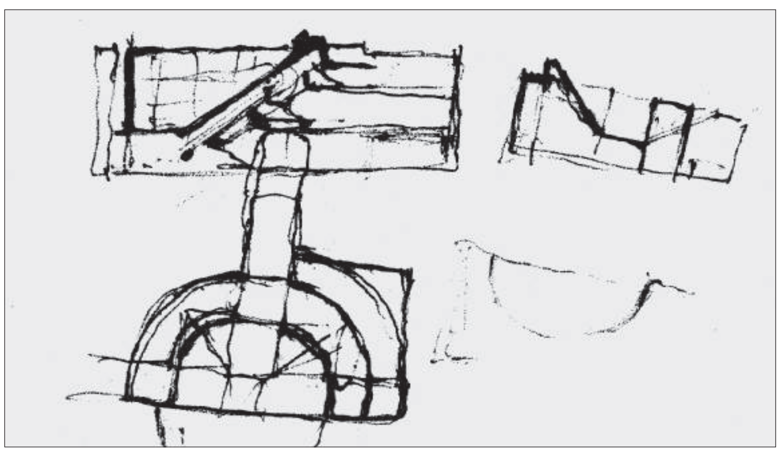
299 Relation schema + valuation

A next step consists in determining the relations between parts and characterising them.

300 Typing

Guided by the programme of requirements and the relational schema I determine the total concept. I am looking first to what I have got in hand. How much office surface is required? Is it an office with additional functions or a hall with offices?



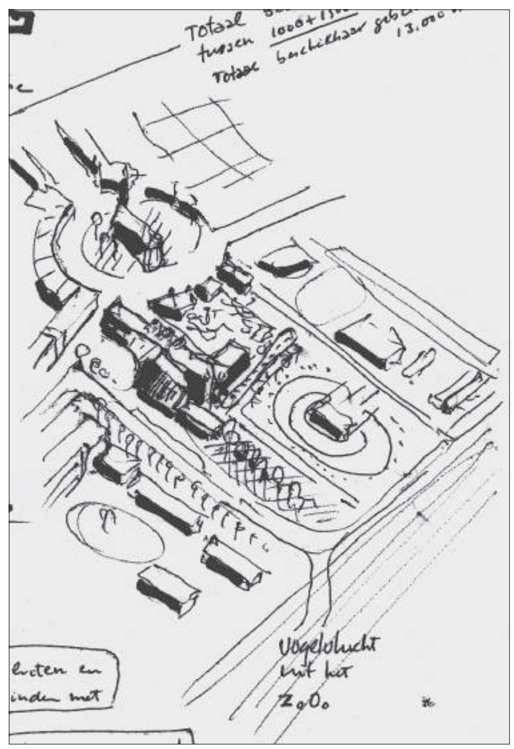


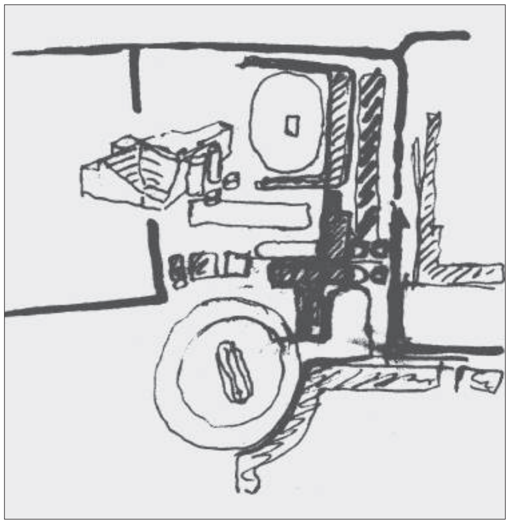
301 Scale relation study

I study possible organisations for the building and proportions of the parts of the building.

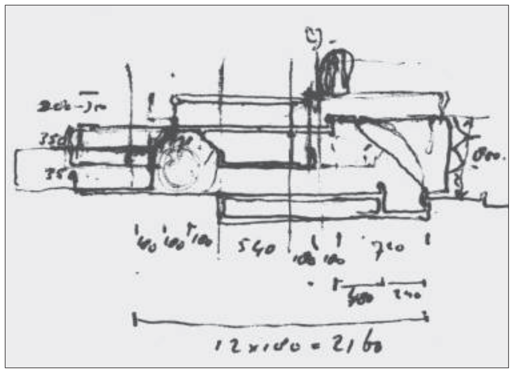
302 Urban context

What the study of the programme of requirements has yielded as a whole is placed in context in terms of urban architecture. This will result in morphological requirements for the surroundings. In a small sketch in perspective I look at whether something can be made of this.



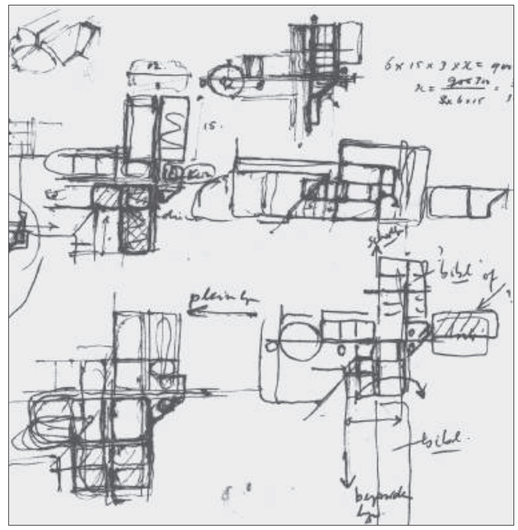


303 *Test of form*

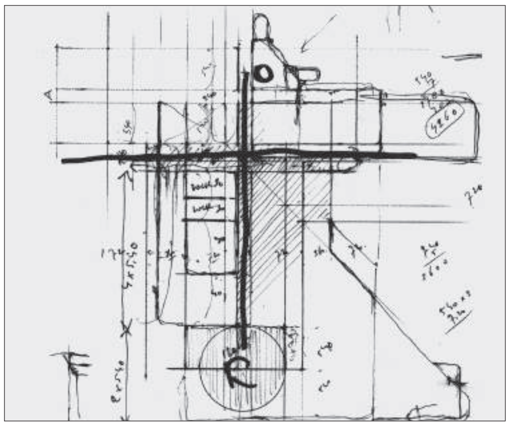


304 Cross-section

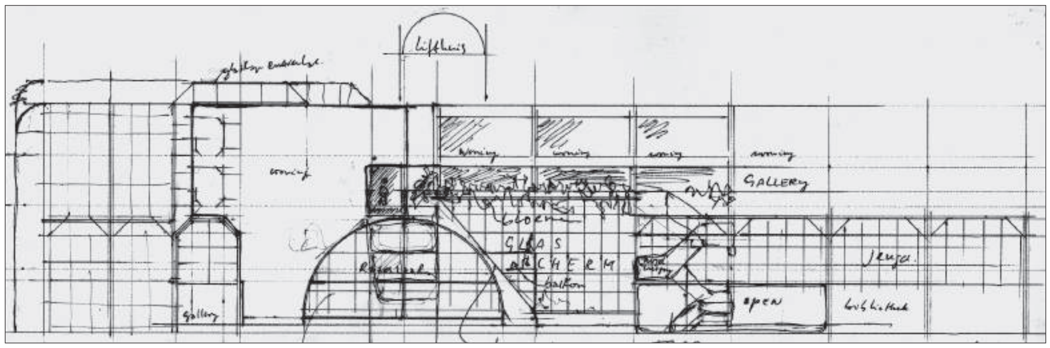
Following this, the elaboration in floor plans and cross-sections starts. I consider it to be very important, that this is done directly in the right proportion and scaling. These small sketches are acting as further elaboration of the design ideas in my head.



305 Loose sketch

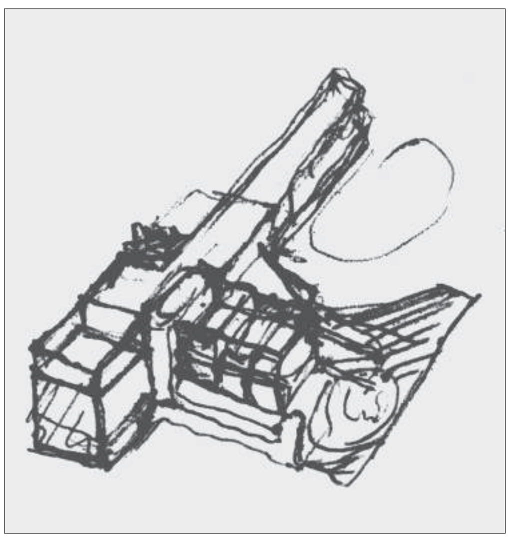


306 Sketch with a ruler



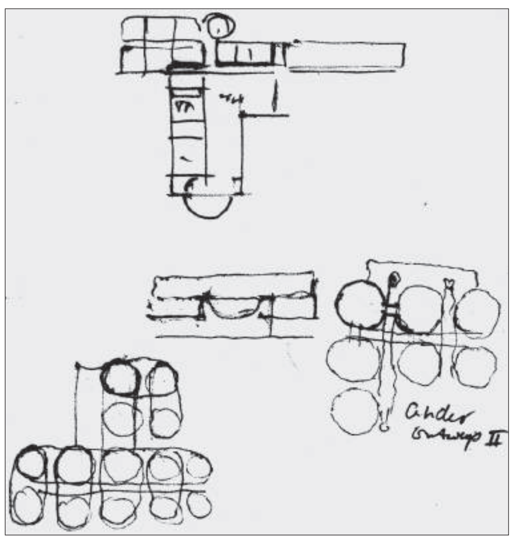
307 Study of the front

Next, I study colour and texture of the front. Any number of these modest studies is being made. If I run into something of importance, I just make a note.



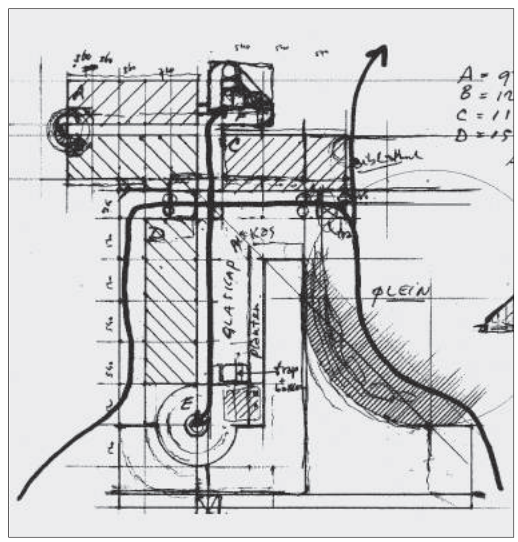
308 Spatial sketch

A spatial sketch, to look again whether it is any good.



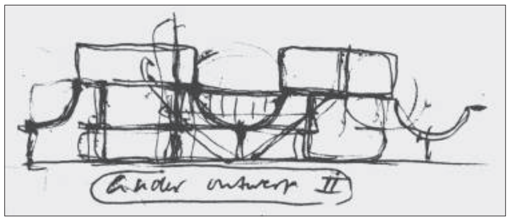
309 Different design ideas

While studying a detail of the building, a different design idea emerged: some upturned halved spheres forming corridors through the space they are leaving open. A nice idea, a kind of fascination: something for a following design.



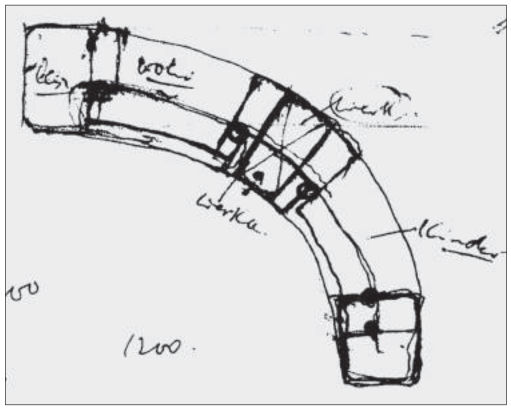
310 Context

Then, study of the adaptation in the urban context, as far as entrance and accessibility are concerned.



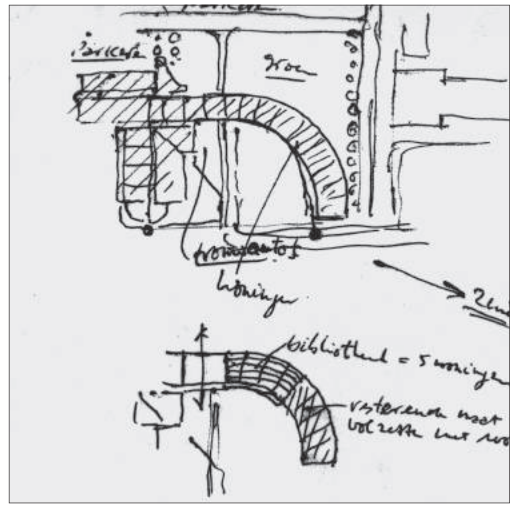
311 Come-back of an idea

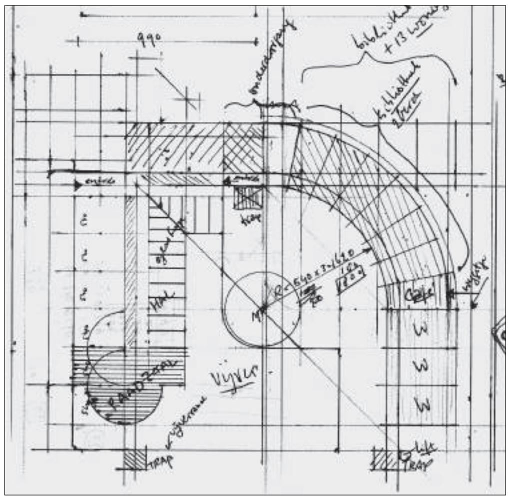
On the corner of the page the other design theme is returning. Maybe I also saw in this a solution; or maybe I was uncertain about the solution on which I was working; or maybe I just had fallen in love with this idea.



312 Adding functions

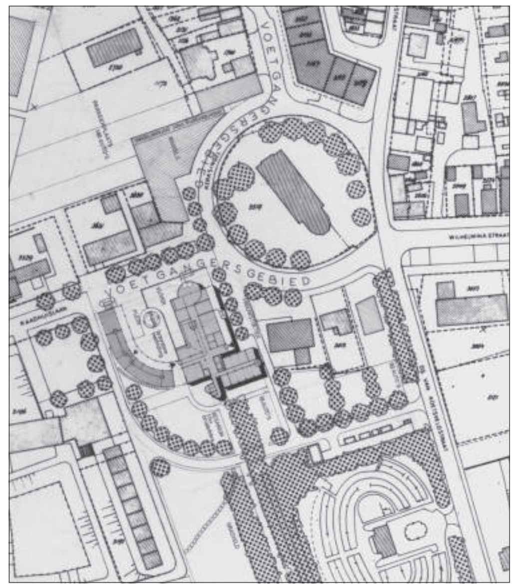
It was permitted to add a few programmatic components. I added some homes and a library. Obviously, no further study of a programme of requirements for the homes was necessary: a house is a house.

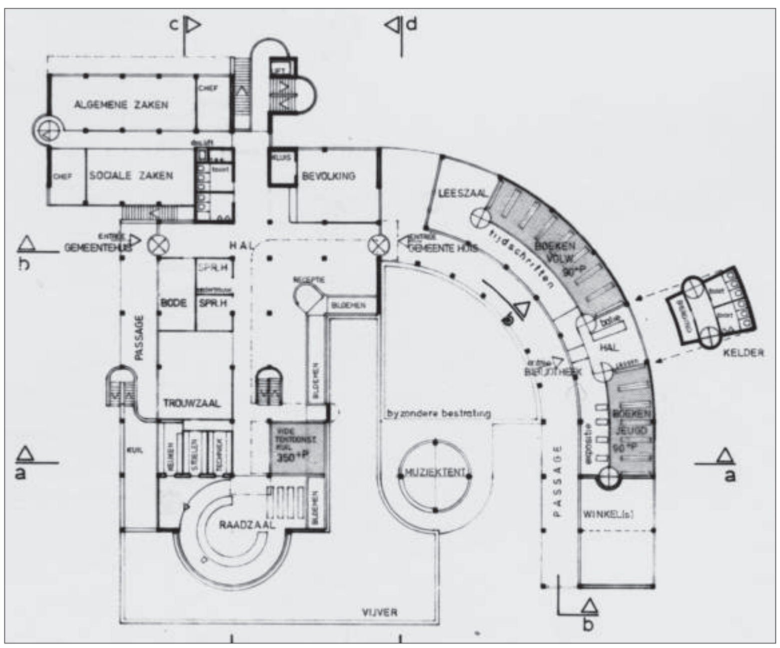




313 Library study

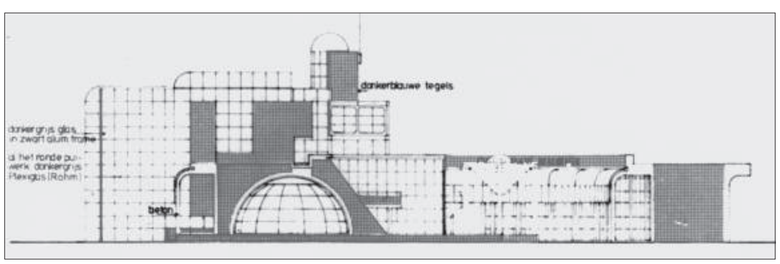
A simple design study for the library. The envelope for it hailed back to the design of the City Hall. For the rest, it was matter of connecting with the programme here. I have partitioned it in segments preceding fitting it in with the programme.





314 Final drawings

During the production of the presentation drawings, I work with a pencil and a pen in hand. In the way I work, I calculate before I draw; so there is not much going wrong. In addition you already see, before you start with ink, and while drawing the auxiliary lines, whether something is going right or wrong. My sketches are illegible and introverted. Designing this way is individual.



31.3 LOOKING BACK

Is this report of sketching happening in your head?

This is not a report of sketching but an elaborate programme of requirements study; I am doing this for each design.

You are unleashing your design idea on the urban context. Is this a characteristic approach?

Yes, the programme of requirements is providing a box of building blocks reacting to the location.

What is making for the initial inspiration?

My most important source of inspiration lies in a deadline. The approaching moment of presentation co-erces the making of choices. A deadline is forcing the idea; for that I do not need flowers or things like that. It is just hard work. While your designing experience is growing, you are putting greater confidence in your intuition. I panicked only once in relation to the enduring absence of a design idea in my time as a student. That also proved to be the last time. I have learned to trust the circumstance that design inspirations are coming by themselves. In addition, I have learned that designing is just hard work.

What are you doing with a dead end?

I am experiencing them regularly. But, this is compensated by my systematic way of working. If I have arrived at a dead end, I can just turn the pages back to the moment when it still went alright. It is important to me that my study is written down and dated rigorously.

At the moment I do not need this any more. For the residential project for students 'De Struyck' in The Hague a study of one A4 page was sufficient. Everything that happens, is happening directly on the computer. With a lot of designing experience, you are not in need of sketches any more; you can add the measuring mentally. Students can not do that as yet; they are lacking a sense of scale: what is 1.8 metre, what is a toilet?

What was a decisive constraint?

In practice, the programme of requirements, the budget and the method of building are decisive. And the image you have. What are you after? The shift from the programme of requirements to the image is a matter of feeling: it does not yield an image. In India I was fascinated by a red building. I made the decision my next building should become a red one. That was 'De Struyck' in The Hague.

After all, initial inspiration?

Of course one is influenced by the environment. Are not all young architects doing the same thing? One is afraid to step out of convention; it is a kind of fashion. Form convention is a more powerful constraint than the programme of requirements.

The residential project for students in The Hague had to be an unconventional building, it had to be disturbing. It is also for students. The municipality went along with this.

Are you not this way part of that convention yourself?

Of course, but with the addition, that I am conscious of that myself. An architect cannot function without convention. Peutz, for instance, designed in one year in all domestic Dutch styles. One did not take that gladly. In the Faculty of Architecture form is associated too tightly with ideology. There should emerge an exercise in convention, so that students would become conscious of these conventions. As a commission, for instance: "Design in the style of the thirties, or the style of Gehry". When you are asking students during the beginning of their study what they consider to be beautiful they tend to suggest 'farmerettes' and their ilk;

when you ask the same question after six months you get as an answer the Van Nelle factory or something like that.

Is your design process methodical?

Certainly; the study of the programme of requirements and the measuring can be ascertained and may be followed up. The form is not developed systematically, the form is a found object, like the colour in India. Sometimes there is a form fascination, like in the design of the city hall. The form arrives suddenly; like in the design for the prison in Schiedam. During the study of the programme of requirements, in one fell sweep, a form idea occurred; and ultimately it was realised. It is a intuitive process surrounding the question: under which form may the programme be housed?

In our profession there is a lot of flexibility in allocating functions; the relation form-function is very relative in architecture.

Can study in architecture be compared to that in industrial design?

In architecture the relation between the programme of requirements (the properties of the product) and the form are not fixed. Man is a flexible animal. Usage of architecture is determined by behaviour, not by ergonomics like in industrial designing. Behaviour is less readily predictable and open to study. Guidelines for a ramp for a normal human being are, for example, impossible to give. The relationship between form and function can only be given in a reduced form, for humans only in convention. From The Netherlands I can not design a house for an Indian in South-America, although I can design a rifle or a needle; then he even knows its purpose. That is the reason why architectonic study is so difficult; it does allow verification. The failure of a building can always be compensated. And if it collapses, it is not a building anymore.

The programme of requirements is playing an important rôle in architecture, but in spite of that it is only of secondary importance.

Why then so much attention for the programme of requirements?

I am a functionalist; buildings are also being judged according to functionality. The (spatial) form of function is the convention. A lord mayor can also function in an office of 10 m^2, instead of one of 40 m^2. Form convention is important; without it we could not design. The description of sleeping is not leading to the form of a bedroom, nor even to the form of a bed.

32 DESIGN BY OPTIMISATION
AN OPEN DECISION-MAKING APPROACH

PETER PAUL VAN LOON

In this contribution it is assumed that designers in architecture and urban planning constantly strive to improve their design. In doing so, they act as rational actors who, as soon as they see opportunities to improve proposals, will no longer be satisfied with their existing ones. Designers will continually strive to achieve the best result possible. In other words, they optimise outcome of their work. This process is referred to as design by optimisation, and the outcome as the optimum design, the definitions of which I shall build into this Chapter.

Some 25 years ago, the design process in architecture and urban planning was almost always headed by one, perhaps several architects, or in the case of large-scale projects, several urban designers. Today, however, a comprehensive design team consisting of all organisations involved is responsible for the process and its results. In consequence, nowadays designers other than architects also have direct and strong influence on the design: structural engineers, costing experts, traffic engineers, building contractors, governmental planners, also users, investors and local residents.

For co-operation between all these experts, specialists and decision-makers a new methodology, called 'Open Design' has been developed by the author. This methodology reflects the necessarily 'multi-actor' or 'multi-party' negotiation and decision-making in current architectural and urban design.[a]

In Open Design, the terms 'designer', 'group', and 'optimum design' are interpreted more broadly than is common in established design methodology. A designer is anyone who has an impact on a design, whether professional or not. The group of designers, therefore, also includes non-professional designers. Which design result is considered optimal is decided jointly.

The Open Design methodology consciously distances itself from the position adopted by many professional designers, who believe that professional group optimisation must be regarded as distinct from, and a necessary pre-requisite for, social group optimisation. In other words, the study sees the optimum social design not as deriviation from optimum professional design. Professional designers often refer to the social optimum as a political compromise. Such a distinction can not be drawn, and the order in which these two optima come about can not be dictated. A professional design also incorporates social views of the professionals and therefore implicitly includes their social group optimum. And a social design incorporates technical views of the non-professionals, thus implicitly including their technical group optimum. They are therefore two aspects of the same design.

32.1 THE DESIGNER AS HOMO ECONOMICUS

Optimisation is, within the context of rational action, goal-orientated. Rational, goal-orientated action differs from traditional action determined by custom. It also differs from affective action, which involves unrestricted response to external stimuli and from idealistic action, whereby the individual does what he considers to be his duty, irrespective of results.[b]

As far as rational goal-orientated action is concerned, one distinguishes between economic and non-economic goals. Economic goals are those which require use of scarce resources that could be used alternatively. All other goals are non-economic. It is possible for economic and non-economic goals to conflict. For instance, if a private individual seeks to meet his accommodation needs rationally and economically by having an affordable (cheap) house designed and built, this might conflict with his non-economic goals regarding the (expensive) aesthetic quality and status of the house.

a Loon, P.P. van (1998) *Interorganisational design, a new approach to team design in architecture and urban planning;* Gunsteren, L.A. van and P.P. van Loon (2000) *Open design, a collaborative approch to architecture.*

b M. Weber, 1922 in: Doel, J. van den (1978) *Demokratie en Welvaartstheorie.*

In the seventies it was assumed that, in order to be rational, an actor acts as a Homo Economicus who[a]:

- is fully informed about the various economic options;
- operates completely rationally;
- aims to optimise the expected economic value;
- and is influenced by measurable results only.

These assumptions later came under heavy criticism. Complete information is never available, no one behaves in a completely rational way, people do not always strive to achieve the best result, and results, also not to be measured, play an important rôle. As more insight was gained into the actual state of affairs, it was concluded that an actor is not always consistent and focused. Human action also involves intuition, tradition, trust and impulse. Goals are often determined after choices have been made. Decisions are, therefore, often made in an unpredictable order.[b]

32.2 GOAL ORIENTATED DESIGN IS NOT DOOMED TO FAILURE

This is not to say that every method in design and decision-making, which assumes that an actor tackles his problems in a targeted and focused way is doomed to failure.[c] One can regard many, if not most, activities as focused. Nevertheless, one should be aware of the fact that there are, in reality, situations in which designs and decisions come about without explicit goals. In these cases appropriate goals are set both during and after the design/decision-making process. In such situations it is still possible to reconstruct the relationship between goal and solution.

In decision-making theory, such situations are said to involve 'limited rationality', indicating the limitations of people as decision-makers.[d] These limitations are connected to: the image of a decision-making problem (lack of knowledge means that the problem is not always a 'given fact' and is therefore difficult to define and the image is limited and subjective); the availability of solutions (alternative solutions are not usually provided, but have to be sought or devised); the awareness of the effects of solutions (It is often not known what can be achieved with a particular solution).

32.3 DESIGN AT A SATISFACTORY LEVEL

Herbert Simon[e] postulated that it is not always possible to maximise profits, and introduced the idea of the 'satisfying' principle (minimising complications and risks).[f] This holds that actors strive only to achieve a limited, usually concrete level of aspiration, because their image of a problem is limited by incomplete knowledge and shortage of time to spent on the problem solving process and because solutions still have to be devised and the effects of the solutions are not entirely known. The criterion is then not 'the house must be as big as possible' but 'the house must have 200 m^2 of floor space'.

Describing decision criteria as specific levels of aspiration offers important practical and theoretical advantages, even if those involved have only a vague notion how their situation could be improved. It is an unambiguous means of measuring whether the goal has been achieved.

Van den Doel (1978, p. 40) states that the fact that formulating decision criteria as 'levels of aspiration' offers advantages must not automatically lead to the conclusion that individuals do not seek to achieve a maximum. The inaccuracy of this conclusion can be demonstrated by distinguishing between subjective and objective rationality. A decision is subjectively rational, if a decision-maker attempts to maximise his goal function. It is objectively rational, if this maximum is actually achieved. The gap between subjective and objective rationality arises partly because of lack of information about alternatives and their implications, and partly

a Davis, G.B. and M.H. Olson (1985) *Management information systems*. p.231
b Boersma, S.K.T. (1989) *Beslissingsondersteunende systemen; een praktijkgerichte ontwikkelingsmethode*, p. 39
c Doel, J. van den (1978) *Demokratie en Welvaartstheorie*, p. 39
d Boersma, S.K.T. (1989) p.23.
e Simon, H. (1957) *Administrative behavior;* – (1969) *The sciences of the artificial*.
f Boersma, S.K.T. (1989) p. 20-22.

because of the impossibility of taking all information into account. The actor optimises: he looks for the best solution from given, offered or known solutions.

In terms of design this means that the designer attempts to achieve a satisfactory level of design result. Achieving this does not necessarily mean he will always be entirely content. For instance, as soon as he receives more information, his level of aspiration will rise and he will attempt to reach that level.

32.4 THE COMBINATIONAL EXPLOSION OF SUB-DESIGNS

These ideas about optimisation on the part of the individual designer are often also applied to whole design teams. In a team, all members' ideas and proposals are collected, arranged in order of preference and combined with alternative solutions. The team then chooses the best. This represents the basis of what we might call 'classic' (or 'systematic') design methods, most frequently used in practice. These methods developed from a succession of techniques, allowing teams to combine and select more effectively, more efficiently, more rapidly.

However, once design commissions became more complex and teams more inter-disciplinary and larger, the design process began to run aground more frequently. The enormous number of sub-solutions produced in these large teams and the complexity of combining alternatives meant that it became impossible to find solutions satisfactory for everyone. The technical refinement of classic methods, refinements in terms of the calculation procedures for combination and selection, did not solve the problem. On the contrary: they allowed so many possibilities, that they caused a combinational 'explosion' (see page 208). In other words, the calculation time needed to find the best combinations from all possibilities had become so excessive that the process had become virtually unmanageable.

In practice, many professional designers therefore rejected the systematic design methods they had been taught, simply in order 'to make good plans', they then tried to sell using charisma and powers of persuasion. In so doing, they turned their backs to a large extent on team design.

32.5 THE DESIGNER AS HOMO SOCIOLOGICUS

In the shift from classic design methods, based on the individual situation, to the group situation, design methodology overlooked the fact that these methods were based on an excessively narrow definition of rationality: the rationality of Homo economicus of the 1970s. The idea that a decision-maker, or designer, in the process of optimising, rationally compares conflicting preferences and arranges them in a fixed order before choosing the best one and that the designers in a team, in the process of optimising, also make a rational comparison and determine a fixed order, then for all preferences together, before choosing, is too limited for team design.

Later, in the 1980s, rational choice theory showed that rational decision-making in groups could also be structured using a broader definition of rationality. The image of Homo Economicus was replaced by Homo Sociologicus, thus replacing economic rationality with sociological rationality.

Pellikaan and Aarts summarised this by distinguishing between the thick theory of rationality and the thin version.[a] Thick theory assumes maximisation of the outcome and specifies the goals, objectives and preference orderings of actors. Thin theory assumes some sort of maximisation and specifies conditions for the preference orderings of actors, but does not specify any particular goal, objective or preference ordering.

This difference can be illustrated using the well-known Prisoner's Dilemma from decision-making theory (a theoretical formulation of a human dilemma that had already been described by philosophers like Hobbes and Hume).

a Pellikaan, H. and K. Aarts (1996) *Potential and actual social dilemmas, rational choice in survey research*.

Row – Player		Column – Player: Co-operate / do not Confess	Column – Player: Defect / confess
	Co-operate / do not confess	Outcome Q (1 year, 1 year) Neither player confesses the major crime; they are tried for minor crimes and get one year each.	Outcome S (20 years, 0 year) The column player turns state's evidence and is freed. The row player is convicted and gets twenty years.
	Defect / confess	Outcome P (0 years, 20 years) The row player turns State's evidence and is freed. The column player is convicted and gets twenty years.	Outcome R (10 years, 10 years) Both players confess, are tried for the major crime and get ten years each.

315 The outcome matrix of the original Prisoner's Dilemma (after: Pellikaan and Aarts, 1996)

	Column – Player: Co-operate	Column – Player: Defect
Co-operate	Outcome Q (3,3).	Outcome S (4,1) a
Defect	Outcome P (4,1)	Outcome R (2,2)

316 The payoff matrix of the original Prisoner's Dilemma (after: Pellikaan and Aarts, 1996)

In the original Prisoner's Dilemma two players have a choice between two strategies: co-operate (do not confess) or defect (confess). The combination of two players with two possible strategies yields a matrix with four possible cells. Figure 315 is the outcome matrix of this game, describing the physical consequences for every possible combination of choice by both players. The outcomes in figure 315, however, do not imply the dilemma. The dilemma only arises after the players have established their utilities or payoffs for the four outcomes.

The problem in figure 315 is one-dimensional because the players are assumed to consider only the self-regarding motive indicated by the number of years they personally will spend in jail. The self-regarding motive 'prefer a shorter term for yourself to a longer term' leads to the following preference ordering: 0 years > 1 year > 10 years > 20 years. This preference ordering corresponds with P > Q > R > S or, for short, PQRS.

The preference ordering PQRS is the so-called Prisoner's Dilemma or PD-ordering. The PD-ordering is a plausible ordering for every individual placed as a (row-) player in the outcome matrix of figure 315. If both players have a PD-ordering the game becomes a Prisoner's Dilemma. The payoffs in figure 316 define the Prisoner's Dilemma game. Both players have a dominant strategy (Defect), and the result of the game is mutual defection.

The Prisoner's Dilemma was often used to show that methodological individualism and, consequently, individual pursuit of maximisation of utility, leads to a less-than-optimum collective outcome. This justifies the enforcement, from outside the group, of co-operative behaviour that would be beneficial for both players - enforcement by government or management.

These bodies do not decide what the best outcome is; they have no goals or preferences of their own, but enforce co-operation so that the individuals achieve a group optimum.

The PD model is often extrapolated to the N-individuals situation. The number of combinations of strategies then grows exponentially. Without co-operation enforced by some central authority, the collective optimum could never be achieved in an N-individuals group.

However, enforcement of mutual co-operation in groups has led to many drawbacks. Not everyone can be forced to co-operate always. Power to enforce the optimum will be limited in an open, democratic, community. There will be no consensus that people must be forced to co-operate on all collective dilemmas. An alternative for central enforcement was then sought in co-operation on the basis of commitment to others and social norms. But, because people did not always choose to contribute to collective matters, it was not possible to achieve the group optimum in some cases. The search then turned to co-operation based on the notion that iterated choices can generate co-operative behaviour. The rational actor will choose a conditional voluntary co-operative strategy. But, in a large group of actors a common knowledge of each other's behaviour was not feasible. Individual actors still preferred unilateral defection to mutual co-operation.[a]

One common feature of these three types of 'enforced' co-operation is the assumption that each individual is selfish and that this can only be held in check by central authority, commitment to others and social norms. Pellikaan introduced an alternative to this assumption: the actor's viewpoint (based on the thin theory of rationality).

The actor's viewpoint assumes that even given force, commitment to others and social norms, actors can adopt a co-operative attitude. This possibility arises because the individual's efforts to maximise utility do not mean that he seeks to achieve selfish aims. People are not selfish by definition.[b] This implies, that individuals have their own subjective preferences, their own view of the best outcome, and that in a group there will always be several preference orderings for one and the same group dilemma. Only in practice will it become clear whether a specific collective issue that is a dilemma on paper will actually appear so in

a Pellikaan, H. and K. Aarts (1996) *Potential and actual social dilemmas, rational choice in survey research.*

b Pellikaan, H. (1994) *Anarchie, staat en het Prisoner's Dilemma.*

reality. And, conversely, an issue that on paper seems uncontroversial might turn out to be a dilemma in practice.

In short, one cannot say in advance how preferences and goals will be weighted. This can only be established on the basis of concrete actions. I shall look at the optimum inter-organisational design from the actor's viewpoint below. In terms of my study as a whole, this viewpoint means that actors (designers) must, above all, have the opportunity, as they work together, to weigh up their preferences and goals during the design process. The design method they use must cater for this.

32.6 FOUR DEFINITIONS OF THE OPTIMUM DESIGN

No conceptual framework exists within which the term 'optimum design' can be unambiguously defined. Widely varying interpretations and definitions can be found in the literature. I shall divide these interpretations into four categories of conception of the optimum and the optimum design solution:

a. design conception, concerning the optimum form;
b. planning conception, concerning the optimum choice;
c. mathematical conception, concerning the arithmetical optimum;
d. welfare economics conception concerning the optimum distribution.

a. *The optimum form*

The design conception of optimality and the optimum design can be found in architectural design theory and also in general design methodology. Here, one is concerned with 'good' design, the 'best' design and 'high-quality' design. Architects often use the term 'optimum form'. The differing theoretical and methodological bases are found mainly in design and design method manuals.[a]

The design conception can be characterised by three aspects of the optimality of a design. The first concerns optimum quality; mainly the architect's concern. Architects believe that their most important task is to create a design of the highest possible architectural quality. In their view, this quality is defined in the debate among architects themselves and between architects and their critics. This determines the different movements, what style is acceptable, and what is regarded as good and bad quality (see legislation governing the architectural profession).[b] The best designs are those, which the architectural profession and its critics regard as the best. A similar process is found in the arts (visual, music, dance, etc.). It is often said that the process has to work in this way because outsiders (principals and users) do not know what 'architectural quality' is. Only the professionals can decide this.

The second aspect concerns the optimum selection and combination of sub-solutions, defined by design theorists. They hold that an optimum design can be achieved only through an optimum design process. The design process is optimum only, if all sub-solutions are first systematically and explicitly collected and selected, after which the selected sub-solutions are gradually combined. It is recognised that the choices made during the selection and combination process are determined not only by the requirements the new product will have to meet (never clear and comprehensive), but also by the inventiveness of the designer and the generally accepted wisdom at that moment about what is best, or what is normal and *en vogue*.

The third aspect involves meeting the requirements the optimum way, the most practical of the three. It is assumed here that the requirements of a principal have been formulated in such a way that the designer knows exactly to what extent his design meets them. They need not be comprehensive and explicit right from the outset; they can be finalised during the process. However, principal and designer must stick to their rôles: the principal formulates requirements, designer finds the solutions.

a Jones, J.C. (1970) *Design methods: seeds of human futures;* Broadbent, G. (1973) *Design in architecture: architecture and the human sciences;* Foqué, R. (1975) *Ontwerpsystemen, een inleiding tot de ontwerptheorie;* Lawson, B.R. (1990) *How designers think, the design process demystified.*

b VROM, Ministerie van (1987) *Wet op de Architectentitel*.

In the past many attempts were made to link the three aspects methodologically. The systems approach, particularly its mathematical side, and operations research were usually taken as a basis. The idea was not to create mathematical models for the design process but to analyse it systematically, almost mathematically, and divide it into a large number of sub-processes. Methods for structuring the individual sub-processes were developed, so that optimum partial results could be achieved. A whole generation of design methods emerged this way in the 1960s. Jones (1970) managed to bring some order to the chaos created by this proliferation of new design methods.

However, after many studies and experiments, it became clear that this was no way to determine the conditions required for an optimum design. It was found that an optimum design is not simply the sum of optimum sub-designs. Foqué maintains that the attempts at integration were too technocratic, based on an exclusive belief in the logical analytical thought process, in total rationalisation of action and in 'scientific method'.[a] This negative conclusion dogged the development of design theory and design methodology for many years. In the 1980s, with the advent of computer aided design techniques (CAD), it was given new life. However, renewed study of optimum design has yet to get off the ground.[b]

b. The optimum choice

The planning conception of optimality and the optimum design can be found in planning theory. This conception is an elaboration of one aspect of the design conception: optimum combination of sub-solutions. Planners refer to the 'optimum choice from alternative possibilities'.

Planning theory assumes that the problems planners are called upon to solve are ill defined. There is uncertainty both as to the environment within which the problems arise and as to the values and objectives one must attempt to achieve. This means the problems cannot be fully quantified and, consequently, quantitative planning techniques cannot be used. In order to achieve an optimum outcome nevertheless, a 'rational planning process' must be followed: *"enumerate the finite number of alternative programmes, evaluate them and select one, thereby invoking a decision rule like (mathematical, PPvL) optimisation"*.[c]

Several authors developed prescriptive models for the planning process along these lines.[d] They see it not as a strict timetable of activities which is determined in advance, but as a learning process: the more problems come to light, and the more alternative solutions are devised, the better one will understand the problem and the better solutions one will find. If this process is structured systematically and rationally, the best (optimum) plan comes about 'automatically'.

c. The arithmetical optimum

The mathematical conception of optimality and the optimum design can be found, inter alia, in operations research (OR), where the term arithmetical optimum is most commonly used.[e] Operations research is *"the application of scientific methods, techniques and tools to problems involving the operations of a system such as to provide those in control of the system with optimal solutions to the problem"*.[f] Mathematical decision-making models are central. Operations research is concerned with 'the scientific method', i.e. 'a scientific (typically mathematical) model' which reflects the essence of how a real decision-making problem is constructed, and can then be used to calculate the optimum outcome. It is assumed that it is possible to create a mathematical representation of reality allowing mathematically optimum solutions to be derived valid in terms of that reality.

In operations research a number of models have been devised for various types of decision-making problems.[g] Although these models are complicated from a mathematical point of view (practical problems are always complex), their basic structure is simple.[h] This structure can best be illustrated using the linear programming model (LP model).

a Foqué, R. (1975) *Ontwerpsystemen, een inleiding tot de ontwerptheorie,* p.63.
b Loon, P.P. van (1998) *Interorganisational design, a new approach to team design in architecture and urban planning.*
c Faludi, A. (1973) *Planning Theory.*
d Friend, J.K. and W.N. Jessop (1969) *Local government and strategic choice, an operational research approach to the process of public planning;* McLoughlin, J.B. (1969) *Urban and regional planning, a systems approach;* Chadwick, G. (1971) *A systems view of planning, towards a theory of the urban and regional planning process.*
e Ackoff, R.L. and M.W. Sasieni (1968) *Fundamentals of operations research.*
f Boersma, S.K.T. (1989) *Beslissingsondersteunende systemen; een praktijkgerichte ontwikkelingsmethode*, p. 18
g Ackoff, R.L. and M.W. Sasieni (1968); Wagner, H. (1972) *Principles of operations research.*
h Boersma, S.K.T. (1989) p. 52-54.

The LP model consists of a set of linear equations (equalities and inequalities) (see page 221). This model can be solved mathematically using the simplex algorithm (see page 223). Its application is known as linear programming: the determination (systematic calculation) of the minimum or maximum value of a linear function (objective function) in the area defined by the linear equations (constraints). The problem faced by the housing association at the end of this Chapter is an example.

In OR, the mathematical definition of the optimum design is fairly simple: the outcome of the mathematical model whose value for the objective function is best, i.e. highest in the case of maximisation, or lowest in the case of minimisation.

Mathematical optimisation is used for many economic and commercial problems. In such cases, mainly financial and organisational goals are optimised: maximum profit, most efficient allocation of responsibilities, fastest production flow. It has also been used in building and urban development, and again in financial and technical objectives (like the maximum number of houses in area B, optimum division of floor space and land use, minimisation of energy consumption, etc.).[a] Goals concerning things like quality of the living environment, equitable distribution of space and preservation of existing culture or environment do not figure. 'Soft' social interests have always been put off by the technical nature of mathematical optimisation. This is not justifiable, since quality, equity and the like also lend themselves to mathematical optimisation.[b]

d. The optimum distribution

The last conception of optimality and the optimum design is derived from 'welfare theory'. As far as I am aware, welfare theory is not concerned with design - unfortunately, since this theory could have important implications for decentralised design, especially design projects that have to be completed in a dynamic decision-making environment. Welfare theory allows a link between democratic decision-making on one hand, and design within a team on the other.

Welfare theory is part of economics. Its exponents concern themselves with group welfare, by which they mean not the material wealth in itself of a particular group but the group's welfare to the extent that it is dependent on scarce (economic) resources. Welfare theory studies the allocation of resources, usually in the form of public goods, within a group (a society), including both costs and benefits associated with a particular allocation.[c]

Pareto's criterion provides a scale for measuring increase in the collective welfare of a group.[d] It is deemed to have increased if the welfare of one or more members of the group increases, without diminishing the welfare of other members. The criterion not only comprises a measure of the direction of change, but also its end point. According to it, collective welfare is optimal as soon as it is no longer possible to increase the welfare of one or more individuals without decreasing that of one or more of the others.

Pareto's criterion does not imply a value judgement.[e] It does not dictate that collective welfare must increase, but merely offers a means of measuring increase. It must be known which groups are enjoying the increase. *"If, for instance, it is only individuals with a relatively high income who profit from an increase in welfare, the change merely accentuates the unequal distribution of wealth and can be rejected on these grounds, despite the fact that Pareto's criterion has been met"*.[f]

If a design is regarded as a plan for distribution of costs and benefits among parties involved, Pareto's criterion can be applied. The design is then optimum, when it can no longer be improved to the benefit of one or more of those involved without diminishing the benefits enjoyed by one or more of the others, benefits they would enjoy if one of the earlier versions of the plan were implemented.

a Catanese, A.J. (1972) *Scientific methods of urban analysis;* Lee, C. (1973) *Models in planning, an introduction to the use of quantitative models in planning;* Lee, C. (1973) *Requiem for large scale models;* Radford, A.D. and J. Gero (1988) *Design by optimization in architecture, building and construction*.

b See: Gunsteren, L.A. van and P.P. van Loon (2000) *Open design, a collaborative approch to architecture;* Loon, P.P. van (2000) *Design by optimization*.

c Doel, J. van den (1978) *Demokratie en Welvaartstheorie*, p. 22.

d Pareto (1906), in Doel, J. van den (1978) p. 59.

e Doel, J. van den (1978) p. 60.

f Idem.

Practical objections to Pareto's criterion arise from the fact that changes in welfare seldom meet the criterion, since almost every gain for some entails loss for others. Van den Doel mentions the 'compensation principle' formulated to overcome these objections.[a] This principle involves assessing whether the 'winners' are able to compensate the loss suffered by the 'losers'. *"If the winners enjoy such a large profit that, after the losers have been compensated for their loss, a net profit still remains, it may be said that the change in welfare is potentially an improvement in terms of Pareto's criterion"*.

32.7 THE OPTIMUM DISTRIBUTION INTEGRATED WITH THE ARITHMETIC OPTIMUM

The four conceptions can be integrated into one definition by expanding the welfare conception to encompass the others.

The welfare conception and Pareto's criterion are used in practice only to discuss actual changes in collective welfare. But, the theory can also be used to analyse welfare changes in a 'designed', not yet effected, distribution of costs and benefits, as indicated above. The theory is then applied during the process in which a group (society) makes and discusses proposals for allocating the finite resources available. The final proposal accepted by the group can then be put into effect and separately evaluated in terms of welfare theory.

In this context, there is a major difference between the design and the implementation stage. At the design stage, the group can freely put forward and discuss proposals. Positive and negative impacts on collective welfare exist only on paper and are therefore intangible. This freedom no longer exists at the implementation stage, since each action has a tangible effect.

If Pareto's criterion is used at the design stage to measure changes, the group can explore all kinds of alternative welfare effects and is still free to compare them. At the implementation stage, the existing level of welfare is the benchmark for Pareto's criterion. At the design stage, the group can decide on its own benchmark, what it will take as minimum constraint. Pareto's criterion can therefore be expanded for the design stage, with the following result:

Collective welfare might increase in response to the implementation of a particular design, if the level of welfare of one or more members of the group increases without causing that of one or more other members to fall below a minimum which these members have set themselves.

This implies that part of the group might enjoy a lower level of welfare than at the outset, since the lower limit they have set might be below present level. It might, however, be higher, if the members concerned feel that there should be a certain minimum increase in actual welfare. The optimum design can then be defined as follows:

The optimum design is achieved when the level of welfare of one or more members of the group can no longer be raised without causing that of one or more other members to fall below the new minimum.

The mathematical conception can be brought in at this juncture, although with an altered view of the rôle of mathematical models in finding solutions (or creating designs).

Normally, a tried and tested model will be used to solve a particular problem. The mathematical method, the main structure and most of the model equations have already been determined. Often, many of the inputs are delivered along with the model as fixed data. Users can generate alternative outcomes only by using variations in the free data of the model. The calculation technique assures that these outcomes represent the mathematical optimum. It is therefore virtually impossible for users not sufficiently versed in construction of mathematical models to use the model to find the optimum according to Pareto. The fixed structure and fixed data make it difficult for them to perform the necessary exercises within the upper and lower constraints of the solution space. This is, however, possible if mathematical methods and techniques are used in such a way, that the design team in principle determines and con-

a Doel, J. van den (1978) *Demokratie en Welvaartstheorie*, p. 61

trols everything in the mathematical description of solution space and constraints. The team must have at all times the opportunity to make changes to the mathematical model (equations, structure and data). The mathematical methods and techniques form no obstacle in themselves. A problem arises when a model has many fixed components incorporated by the individual who devised the model, on his own authority, on the grounds that this was the only - mathematically sound - way.

A mathematical description of the optimum group design, which is in line with the welfare definition, might read as follows:

The design is optimal if the value of the objective function cannot be raised (in the case of maximisation) or lowered (in the case of minimisation) without breaching the limits set by those involved.

One example of this is the solution to the problem faced by the housing association in the following.

32.8 THE HOUSING ASSOCIATION'S DECISION MAKING PROBLEM

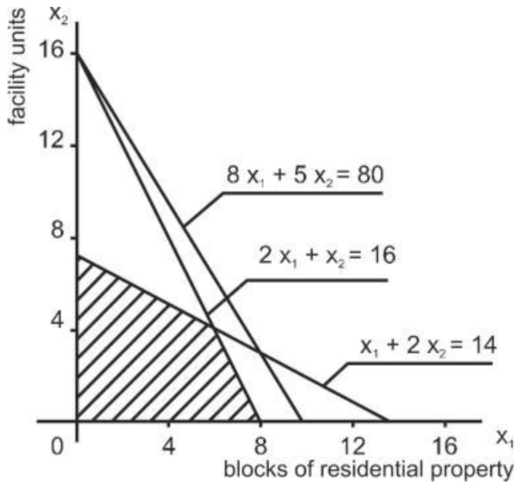
We briefly repeat the exercise of page 221. A housing association wants to build a number of blocks of residential property and facility units (shops, school, social and cultural centre, etc.) on a particular site. The site covers 14,000 m^2. The association hopes to complete the project within 16 months. A block (construction time 2 months) covers 1,000 m^2, while a facility unit (construction time 1 month) covers 2,000 m^2. A residential block costs 8.10^6 guilders, and a facility unit costs 5.10^6 guilders; the overall budget is 80.10^6 guilders. It is not necessary to cover the entire site. A survey has been conducted among future residents. This revealed that they value housing blocks and facilities at a ratio of 5:3. The aim is to ensure that the future residents are as pleased with their neighbourhood as possible.[a]

This problem can be represented mathematically in an LP model. X_1 is the number of blocks of residential property and X_2 the number of facility units. Two decision-makers are involved in this problem: the housing association and the future residents. The housing association decides what site area is to be built on, how long the building work will take how much it will cost and sets out the timetable for the project. The future residents decide on their opinion of the houses and facilities. These give the decision variables. The input variables are the total budget (80.10^6 guilders maximum) and the land available (14,000 m^2 maximum). They have been determined by the local authority within the constraints of its overall urban plan and the regulations governing its housing budget. The future residents want to see their views taken into account to the greatest possible extent, so $5\ X_1 + 3\ X_2$ must be maximised. The housing association wants to complete the project within 16 months and sticks to its decisions regarding construction costs, construction time and site area. These are the goals; they can be represented as follows:

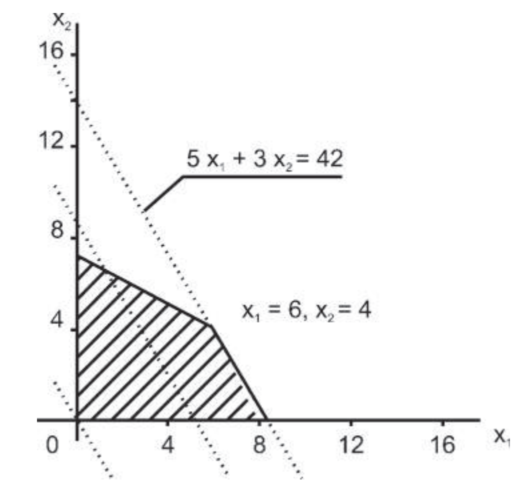
maximise:	$5X_1$	+	$3X_2$			(appreciation)
constraints:	$1{,}000\,X_1$	+	$2{,}000\,X_2$	$\leq$	14,000	(site area)
	$2X_1$	+	X_2	$\leq$	16	(construction time)
	$8.10^6 X_1$	+	$5.10^6 X_2$	$\leq$	80.10^6	(budget)
			X_1	$\geq$	0	
			X_2	$\geq$	0	

The simplex algorithm (a mathematical procedure which allows an LP model to be solved with 2 or more unknown variables) can be used to find the mathematical solution. Since the example has only two unknown variables, it can be solved using a simple drawing. This can be explained simply and allows the mathematical solution to be presented graphically. The problem facing the housing association is represented in figure 318.

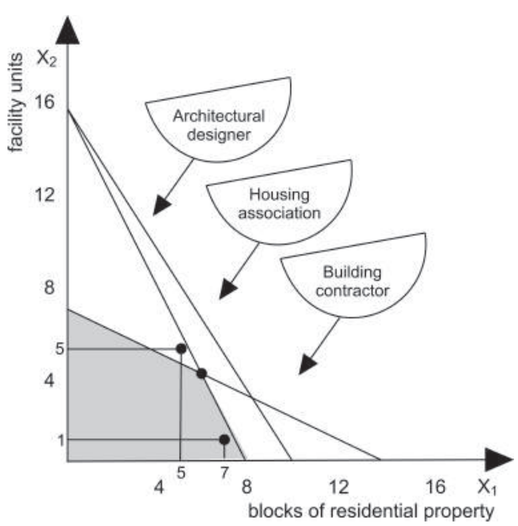
a This example is given by Berkhout and de Graaf, published in Horssen, W.T. van and A.H.P. van der Burgh (1985) *Inleiding Matrixrekening en Lineaire Optimalisering*, p. 57-59.



318 The solution space (shaded)



319 The objective function



320 Position of qualitatively optimum designs in relation to the mathematically optimum design

The maximum value of the linear equation $5X_1 + 3X_2$ (the objective function) must be found within the shaded area. Consider the group of parallel lines $5X_1 + 3X_2 = c$. The highest possible value of c has to be obtained, within the constraints. This can be achieved when $X_1 = 6$ and $X_2 = 4$, because c = 42. The best outcome is achieved with 6 housing blocks and 4 facility units (figure 319).

The housing association and the future residents will undoubtedly continue negotiating their decisions and goals after this 'initial' solution has been found. Such negotiation is useful in order, to establish for instance, whether a change in the construction costs might better suit preferences of the residents. Other, cheaper building materials could lower the costs, which might lead to a better distribution of houses and facilities.

32.9 THE OPTIMUM FORM INTEGRATED WITH THE OPTIMUM CHOICE

The design conception can easily be integrated with the foregoing. The first aspect of this conception - meeting the requirements the optimum way - has already been incorporated into the mathematical definition of the optimum design, since these requirements are represented in the mathematical constraints. The second aspect - optimum selection of sub-solutions - is addressed below, when the planning conception is incorporated. The third aspect - optimum quality - can be integrated as follows. The best alternative designs approved by architects as good, in terms of quality, can be divided into designs which fall within and outside the constraints of the best Pareto solution. This can even be determined unequivocally using a mathematical model. This also applies to designs which lie exactly on the point representing the mathematical optimum: the best designs. However, if there is no design at this point, a choice will have to be made from the designs within the solution space.

In the mathematical solution to the housing association's problem, the position of a design within, or outside, the solution space can be illustrated as follows (figure 320):

a. The quality plan within the solution space

If an architectural design has been made for a residential block that covers 1,400 m^2 of land and a facility unit that covers 2,500 m^2, the new optimum lies at the point $X_1 = 7.2$, $X_2 = 1.6$ (the new site area constraint: $1{,}400\ X_1 + 2{,}500\ X_2 < 14{,}000$). If the figures are rounded off, the architect is actually proposing to build 7 residential blocks and 1 facility unit.

b. The quality plan outside the solution space

If the architectural design requires 900 m^2 for a residential block and 1,800 m^2 for a facility unit, the new optimum solution lies at the point $X_1 = 5.1$, $X_2 = 5.2$ (the new site area constraint is $900\ X_1 + 1{,}500\ X_2 < 14{,}000$). In this case, 5 residential blocks and 5 facility units can be built.

Finally, the planning conception. This plays a rôle in the rational choice of alternatives falling within the constraints. The design team must agree on how to choose between these alternatives: whether to decide by vote, leave it to principal or designer, or to try to reach consensus as a team. The optimum design is the design selected according to the agreed procedure from the alternatives falling within the constraints.

Integration of all these conceptions produces the following definition of the optimum design:

The optimum design is the design selected by an explicitly defined procedure from alternatives falling within mathematically defined constraints accepted by those involved.

This definition is consistent with the Open Design viewpoint from which I looked in this Chapter at multi-actor design optimisation. After all, it includes all key features of 'multi-actor' or ‘multi-party’ negotiation and decision-making in current architectural and urban planning: the organisations involved in the design team determine each independently a part of the solution space; everyone has a say when it comes to selecting alternatives; and the organisations consult about the choices they make.

32.10 ACCEPTANCE OF AN OPEN ENDED OUTCOME

The collaboration between various designers often gets stuck. Solutions to get the ball rolling tend to be characterised by compromise rather than synthesis, as a result of the autocratic way of decision-making by a limited number of expert designers.

Some causes of this rather disappointing state of affairs:

- Combinatory explosion: there are more possibilities, opinions, alternatives than any one player can handle.
- Power games: players try to dominate.
- Unilaterally sticking to certain concepts: architects tend to nourish solutions originating from themselves rather than from others.
- Conflicts of interest: parties try to defend their own interests so vigorously that a solution for the project as a whole becomes impossible.
- Stubbornness: sticking to conventional and familiar concepts.

The process leading to an open design, i.e. a design in which the interests of all stakeholders are reflected in an optimal manner, is complex. To communicate outcomes, to gain acceptance for these outcomes, to avoid stalemate situations, to maintain momentum, etc. – the management of the entire open design process – is in practice even more crucial to success than the methods and computer tools involved.

When the interests of all designers must be incorporated in the design, no one can predict beforehand how the design will ultimately look. Since the end product is unpredictable, the management of open design must focus on process rather than content. The outcome of that process remains open-ended.

33 OPTIMISING PERFORMANCE REQUIREMENTS

PIET HOUBEN

Western societies are changing into knowledge societies. Architectural engineers are expected to change with them as well. Characteristic for a knowledge-based society is inter-action and communication between people with different backgrounds in terms of professional discipline, culture and life-style. It calls for people getting out of the shell of personal professional discipline, of reassuring norms and values, of personal life-style and aesthetic taste; while communicating openly and creatively. The sociologist Jürgen Habermas talks about 'acting communicatively'. The term 'acting' is indicating, that people are conscious about the context in which they meet, prepared to recognise that there are several ways of looking, and that this multiplicity should be catered for in solutions to be designed.

Developing a programme of requirements is a fine opportunity for acting communicatively; since the development of performance requirements for a building is taking place during a process in which several agents discuss and negotiate with one another on the content of these requirements. Sequentially: in the commission, the statement of points of departure, the sketched design, the programme of requirements, and in further documents the performances to be delivered by the building have been made increasingly more explicit; differentiated further and more specified. Certain requirements may well be getting more weight during the process; or may be rather weakened. Particular requirements may end up higher, equal or lower than on the usual moment to assess a certain performance. It is also possible that, ex post performances may be read in the design that were not topics of discussion at all. In such cases it may concern, for instance, routine, prevailing norms or performance requirements based on official prescriptions beyond discussion.

33.1 METHODICAL APPROACH

The present Chapter is dealing with methodical points of departure for acting communicatively in order to formulate performance requirements, from which parties concerned are expecting that they are leading to optimal results.[a] In this context, 'optimising' means to make actors conscious of the fact that they are playing in the concrete situation a rôle in creating the best possibilities for that situation and the near future. The emphasis on 'best possibilities' is related to the fact that by all kinds of modernising trends changes in science and society have come to the fore strongly. If people, professionals, and therefore agents in the design process do not want to be swept away themselves by the present, post-modern stream of changes, it is a necessity to make choices in order to follow that stream as responsibly as possible. In this context optimising is implying that people want to facilitate in the design the development they consider to be desirable.

When agents in a design process want to strive for optimising their choices like that, they should found their considerations well, while inviting criticism; where needed, they are 'criticising' statements on the performances of the building to be realised. In this, criticism means to say: an argued effort to 'improve upon' the statement of someone on a performance, deemed probable or desirable.

These developments show that from the stand-point of methodology allowance should be made for the increasing variety of visions for the performance requirements of the building within a technological and social context, in which a strong pressure heading upwards for quality is prevailing. How to deal with the ensuing proliferation and development of performance requirements? How can there be balanced attention for aspects between content and relation? How can right be done to the fact that the agents in this post-modern era are 'learning' professionals?

a Houben, P.P.J.A.M. (1992) *Methodisch innoveren in de ouderenhuisvesting*.

In order to have the process of critique run well, the following three methodical aspects are of importance:

- Balanced attention for aspects of the process in terms of content and relation
- Critique articulated according to the specific domain of reality
- Phased plan development and crucial rôle of the encompassing concept.

33.2 BALANCED ATTENTION FOR ASPECTS OF CONTENT AND RELATION

Since in all segments of society households of 'command' are making place for 'negotiating' households, communication in the designing process has changed in character. The historical central position of the architect gave way to a situation in which responsibilities for the design were shared by other disciplines. The relationship with the modern commissioner towards a dialogue has evolved as well; while he can formulate – assisted by experts; or not – a clearer picture of the desirable programme of requirements and type of architecture. More than ever before, representatives of the users of the building are voicing what needs and desires live with them in terms of performance requirements.

As in all processes of co-operation, within a team of designing agents communication not only entails exchange in terms of content, but also in those regarding relation. How people relate to one another proves to be at least as important for realising a good design as the quality of the input of content. By the way of communicating a 'platform' must be created, so that all, or at least the most important agents, should be backing the design to be realised. That may be difficult, when certain distributions of power, or forms of dominant behaviour stand in the way of a sound discussion of content. It is not for nothing, that occasionally a process consultant is hired to ensure that aspects of content and process come to the fore in a balanced way.

In today's post-modern times it is striking that performance requirements are changing at a more rapid rate. In the arenas of building technology, architecture and society are causing a sweeping stream in terms of improvement and innovation in buildings. It is characteristic for innovations that they – in contrast with a more gradual increase of the quality in improving – are performing a 'Quality Jump'. This is expressed in a new mix of quality requirements and a more than gradual improvement of quality levels. In order to be able to innovate, agents concerned in the designing process must be open to the most recent knowledge and insight; and to an approach rather more experimental than before. Since the actors are usually only aware of the newest developments in their own field of expertise and social niche, the communication process needs reserve space for discussion. In analogy with the contemporary principle of the 'learning organisation', agents in a designing process will develop themselves mutually, in order to reach better results. So its is desirable, that the designing process should be phased in a certain way.

33.3 TOWARDS A CRITICISM BASED ON A SECTIONALISATION OF REALITY

During the process, discussions are held regarding quite varied performance requirements, some of which will be new to some of the actors involved. Developments and standards within every concerned discipline, changes in norms and notions of quality in relevant social sectors, and increasing variation in forms of lifestyle all lead to dynamics in, and increasing pressure on, the results to be achieved. Based on the developmental perspective on optimisation outlined, a well-balanced way of looking at reality is desirable. An important aspect is that one distinguishes between three different fields of reality in which performance requirements can be developed, to wit:

a. empirical science and technology
b. social values and norms
c. individual preferences and needs, and aesthetic criteria.

Employing this sectionalisation in the criticism process is essential if optimisation is to occur. It is also important that statements about performance requirements in each of these fields be tested against qualification criteria that apply specifically to the field in which they are made. Development in each of the fields becomes hampered, as soon as evaluation criteria from other fields are employed during the criticism process. Developments in society (and the buildings designed for it) benefit from an equality in how these fields are used during the processes of communication and criticism. Before addressing the dangers of using these unequally, let us first identify the most important types of assessment criteria, per field:

a. Empirical science and technology

In the field of empirical sciences and technology, the criteria that apply are derived from description and explanation of phenomena as true to reality as possible; these criteria involve efficiency and suitability of a certain measure. In the design process, the state of science and technology determines the best solution for a problem at that point in time, as well as the performance requirements that can be generated from this solution in the building to be designed.

The field of insulation, for example, deals with statements within this field that exclusively address the insulation value of a certain kind of windowpane, or thickness of the glass.

These kinds of objective statements in the field of empirical science and technology must not be confused with statements about the two other fields. Towards this end, statements about perceivable or expected insulation values must not be confused with society's or an individual's desire for insulation.

b. Social values and norms

In the field of social norms, statements in the design process must be tested against the currently prevailing notions about quality, and the customary norms regarding presentation requirements.

Arguments for criticism can then initially be tested on the basis of how, in the social debate and in the political decision-making process, norms and performance requirements considered desirable by a society are thought of and decided upon. This field has been set in motion, on one hand, by economic and technological developments and individualisation, and on the other by increased information about these things as a result of television and electronic tools. The modern phenomenon of "social debate" facilitates these dynamics. Critical, contemplative science contributes to the clarification of opportunities in these kinds of debates.

On the topic of insulation, for example, the debate revolves around insulation norms that address considerations of a clean environment and durability on one hand, and around affordability and economical feasibility on the other. Again, these kinds of considerations must not be confused with the preferences and tastes of, future users, for example.

c. Preferences and needs of individuals; aesthetic criteria

The third field concerns the one of 'Taste'. It is comprising preferences and needs of would-be future users as well aesthetic criteria regarding designing. Neither the sciences – see the first domain – nor society – see the second domain – can command from an environment in which both domains of reality are equitable, prescribe and ordain what someone needs to experience and think consciously; or to what demands an architectural vision on designing should comply.

It is up to the individual to open up in terms of his/ her feelings and conceptions. Someone else can help that person in the creation of favourable conditions whereby someone can circumscribe and motivate authentic experiences and conceptions. This is particularly important for realising a personal style of living, working and housing. Market studies of the last decades demonstrate that preferences of consumers are becoming increasingly volatile.

Opinions of individual persons, for instance, on heating and isolation may be varying; because of differences in somatic-sensorial experience; in aesthetic preferences regarding noise-isolating measures taken for buildings and in awareness on the use of care for the environment; and thermal isolation balanced against personal financial possibilities.

The same applies to architectural vision on designing. Obviously, discussions about aesthetic perspectives and points of departure are viable, but arguments in the matter do need to restrict themselves to this domain; and should not be entangled with discussions on the functionality of the building to be realised – first domain – or social norms, - second domain.

33.4 PHASED PLAN DEVELOPMENT AND CRUCIAL RÔLE OF ENCOMPASSING CONCEPT

The designing process is in need of a phasing in which the input of each agent is warranted, as well as his/ her potential to learn, and to think along with what other agents are bringing to the fore. Given restrictions in time, this collective process of communicating and learning must get to results in a short period of time that can be surveyed. This is the reason that phasing is desirable during the trajectory of the development of a programme of requirements. Before the design team has formulated the final design requirements, there are two previous stages. The very first is termed ‘shaping of image’; the second ‘shaping of judgement’. The first and second stages are hinging around an encompassing concept of the design. Given the dynamics of technology and society, the first is gaining in importance; however, since it is considered, given its reflective and procedural character as time-consuming, it is often passed-by. In descriptions of design processes the stage of image creation is often resembling a black box. Nevertheless, it is crucial; since the foundation for the design is laid in it.

Stage 1: Creating the image

The first stage departs from clarification of the analysis. Information possibly lacking in the commission is supplemented. During it representatives of the principal and the users of the facilities to be housed in the building are becoming involved with providing input to the discussion. This imagining stage is pre-supposing a ‘free’ exchange between agents on the developments they deem relevant for the design and which may be recognised in various disciplines and social sectors. The agents are wording to what extent they consider to be themselves at home in a given development, and which points of departure and objectives should found the design. They are not to be pinned down on these statements, but should be available to be questioned by other agents critically. The aim is to elicit from each agent increasingly clear statements; not to negotiate with him/ her.

It is essential in this stage of imagining that each agent is at liberty to give his/ her vision on the design to be made. During this stage feasibility should not be held in too high esteem. This would dampen creativity, innovative potential and initiating power of the agents. In it, a maximally large space should be given to learning and developing shared support.

In a process developing well, the statement of a shared concept is crystalised; to which 2 or 3 main variants may be coupled. It is the responsibility of the facilitator of the process to make an effort, at the right time, to name the concept and variants. A useful technique in this regard is the meta-plan method. The prefix *‘meta’* is referring to a higher level of abstraction. Here, concept and variants are worded in their kernel by way of a mission statement; and eventually represented in symbolical drawings. Their meta-level is so high in words as well in images, that each agent is recognising himself in it. This means that a well-formulated, encompassing concept is furthering the supporting forces of the effort; a source of inspiration for subsequent stages.

Stage 2: Forming of judgement

During the second stage, 'forming of judgement', the concept and possible variants are further developed into a programme of requirements, sketched designs and costing projections. With regard to his/ her discipline an agent, or a group of agents, further develops an aspect or part within the framework of the concept and possible main variants. Regularly, the results of the work of all (groups of) agents will be discussed and weighed, in order to see whether the separate detailing is fitting together in the concept and main variants. In principle, this servo-mechanism is just leading to adjustment of the detailing. During this stage all kinds of feasibility checks will take place at given times. During this checking the agents can contribute constructively – on behalf of the principal and the target group that also participated during the first stage and know, by the same token, the 'spirit' of the concept - in commenting on better performance requirements; and thinking along with them. Obviously, it should be ascertained that in these checks the principle of articulated criticism is followed.

Particularly if the pressure on feasibility is increasing greatly, it will show whether the mission statement character of the concept and the initiating and sustaining power of the agents is 'strong' enough for realising the original ideas as much as possible, without relinquishing essential points of departure and objectives. Nevertheless, it cannot be excluded that the concept is in need of adaptation during the judgement forming stage. That is an important moment for enhancing the process in order to see to it that it is happening in a well-considered way. Actually, a new imagining stage must be started in a shortened form. Particularly during the second stage it is important that during the development the feed-back of the development to the concept and in case of feasibility checks the discussion on performance requirements is differentiated according to the domain of reality to which they are relating. The second stage finishes with a preliminary programme of requirements.

Stage 3: Decision making

The third stage, 'decision making', starts with the preliminary programme. The aim of this stage is to get final approval. Adjustment is just possible on minor points. Instituting this stage is desirable, since those holding themselves responsible for realising the programme are comprising a more narrow circle of agents than those active during the first two stages. However it is desirable that the agents that participated during the first stages should be retained; because of their insight in backgrounds and choices underlying the preliminary programme of requirements.

33.5 SOCIAL RELATIONS AND POSSIBILITIES FOR ACTING COMMUNICATIVELY

The possibilities for communicative acting depend on social conditions. It may be stated, looking at the ways in which western societies have been organised, that performance requirements formulated on the first two domains of reality seem to strengthen one another mutually; and dominate the third domain. New discoveries in science and technology, in combination with welfare states and organisations operating globally, striving for modernisation of social institutions, respectively of economic activity, do establish a favourable breeding ground for developing new, and increased demands in these domains. The odds are, that this is happening in disregard of preferences and needs of individuals and aesthetic aspects. In that case a disproportion of statements on the three domains of reality is applying.

It should be kept in mind that during recent years such an individualisation has been going on in society, that the possibility of the individual to design his, or her, life according to personal insights and to steer it in that vein seem to show a nett gain. However, the social-economical position of someone as a principal is depending on his/ her capability to deal independently and satisfactory with technological and welfare innovations. Luckily, during the last decades emphasis on functionality has also been reduced in architecture; and room gained for a larger variety in form and colouring of buildings.

33.6 PRACTICAL EXAMPLE: HOUSING FOR THE ELDERLY

Over the past 15 years, a wave of innovation has become visible in the housing of elderly people. This resulted in new construction regulations, new types of buildings, and new logistics of care and service provision. The innovations are a result of increasing criticism of the traditional approach. Critical questions regarding the three fields of reality:

Sub a: Is it actually effective and efficient to have people moved, as soon as they become less mobile and needy of care, first to special intermediary homes for older people with a mild need for care, and then, as their need for help increases, to a full-time care centre or convalescent home?

Sub b: With an eye towards the greying of the population and the high costs involved, can building and utilisation of care centres and convalescent homes be slowed down? Are there cheaper alternatives?

Sub c: Why do older people have to move when they become in need of care, leaving behind their trusted home and environment so as to move to a special home, or even to a convalescent home? Why are seniors "stored away" in a small sitting room/bedroom (care centre) or in a multi-person room (convalescent home)? Why are intra-mural facilities so large-scale, and why do they have the character of "hospital-like institutions"?

In developing and achieving innovative approaches, a number of discoveries were made now resulting in approaches towards validation:

Sub. a

Adaptable building or renovating of apartments and intermediary forms of residences, specifically aimed at achieving better accessibility to the kitchen and the sanitary unit, helps seniors to take care of themselves, and promotes efficiency of home care. This also applies to the development of various delivery services, specifically in so-called "home care zones" such as those in IJburg, as well as to computer and communication technologies increasing ease-of-use, comfort, and security of the residence. By expanding and intensifying home care, people with a moderate need for help can stay at home longer, and can continue to live in an intermediary form of housing.

Sub. b

These alternative solutions have lead to a reduction in the number of expensive care centres and convalescent homes. It is easier to ask the seniors themselves to contribute and invest, since this allows them to live independently for longer periods of time. This also contributes to savings.

Sub. c

The alternative solutions better fulfil the residential and caring needs of older people. By continuing to live independently for longer periods of time, they feel less discarded, remain active longer, and maintain an interest in the world around them. More small-scale residential possibilities also become available. In design, there is an increasing tendency for architects to warm to the idea of the "apartment" which can also be inhabited by non-elderly residents.

These new basic approaches can be seen in all kinds of innovative projects.[a] Applying them on a large scale, however, is a slow process. Established interests, engrained routines, and viscous bureaucratic procedures all stand in the way of rapid change. Thus it seems that many architects are not well informed about the principles of accessibility, and too little involved in the development of innovative concepts. This results in unnecessary or incorrect solutions. The recently published "*Woonkeur*" consumer approval mark is a good example of practically applicable guidelines based on ergonomic and safety research (Field A), the readiness to build social housing with higher quality requirements and increased value for the future (Field B), and active participation on the part of older people, people with a handicap, and creative architects (Field C).[b] The plans for IJburg are also based on intensive exchange of ideas between experts from many different disciplines and organisations. This has led to an interesting schedule of demands for the district in general, and for care zones in particular.[c]

33.7 EXTRADUCTION: PROGRAMMING STUDY WITH AN EYE ON OPTIMISING

In this Chapter vital aspects of methodical optimising of performance requirements have been sketched for social development. One characteristic of this methodical approach is the search for a balance between analytical and synthetic ways of working.

The analytical aspect shows in clarifying the commission and free association during the stage of image forming, differentiation of performance requirements according to the three domains of reality and testing proposals to improve on them according to the appropriate domain of reality.

The synthetic aspect shows in the balance between content and process, judicious dealing with the domains of reality, 'finding' an adequate concept; while developing and criticising within the framework of the concept the performance requirements. The synthetic aspect is demonstrated by the staged approach, starting with a broad stage of forming the image, proceeding into activities concentrated around a 'concept' during the judgmental stage; and around a preliminary stage of deciding involving the programme of requirements.

This methodical approach demonstrates that starting from empirical study a contribution is viable with regard to probable effects of certain performance requirements; to what the wishes are in society and among users of buildings *vis-à-vis* performance requirements. The methodical steerage of the communication between agents during the development of performance requirements indicated is aiming at making this process transparent and, by that, scientifically verifiable. It has been especially developed for the present, post-modern society, after underlying trends and dynamics were first studied. Experiments with applying it have demonstrated that this methodical approach is working well generally, if some conditions have been fulfilled. A very important one: sufficient time and willingness of agents to invest in the first stage of image forming, was already mentioned. Just as in other designing processes, there are but a few systematic descriptions of experiments like that. Producing these descriptions needs quite a lot of energy; while it should be kept in mind that in publications on these projects the attention of most readers is rather focused on the final result than on the way in which the programme of requirements came into being. On top of that, expectations raised by the programme of requirements and assessment of the building realised eventually do not need to agree. Thus, in those cases the question emerges why one has to go through such a lot of trouble for the description of the process, with a result that, compared to it, is somewhat disappointing. Nevertheless, this disappointing experience can never legitimise denying transparency to designing processes. On the contrary: the importance of transparency – and therefore methodical developing and designing – is increasing; since increasingly better educated, but also specialised professionals and organisations, as well as more assertive consumers are being involved in realising the built environment.

a Houben, P.P.J.A.M. (1997) *Reflexieve modernisering ouderenzorg*.
b Woonkeur, Almere: SKW Certificatie bv, 2000; VROM (2000) *Nota wonen (ontwerp)*.
c Lammers, B. and A. Reyndorp (2001) *Buitengewoon, nieuwe vormen van wonen, zorg en service op IJburg*.

34 THE ENVIRONMENTAL MAXIMISATION METHOD

KEES DUIJVESTEIN

The environmental maximisation method is a design method used by town planners in which an attempt is made to clarify the long-term, ecological approach in such a way, that it is possible to recognise how decisions were made in the final design.

34.1 BLUEPRINT FOR A CITY

The original idea for the environmental maximisation method came into being in the mid-seventies. A research programme, '*Blueprint for a City*', was started in what was then the multidisciplinary Centre for Environmental Science and Technology. The title was inspired by the manifesto '*Blueprint for survival*', written by Friends of the Earth. The research programme had two main aims. Firstly, to encourage inter-disciplinary co-operation. Secondly, to clarify pre-conditions and requirements set by the professions involved in advising the building industry as a whole. What was required was an indication of the ideal extent, density and system of land division for a city or urban area as seen by a particular profession. The question was put to specialists in fields like district heating, use of solar energy, and avoidance of wind problems, public transport and sewage treatment. This kind of approach turned out to be impractical. The advisors were not accustomed even to give an outline answer to such questions.

34.2 URBAN DESIGN AND THE ENVIRONMENT ('SOM')

When the attempt to use staff-members failed, a further attempt was made in 1978 using final-year students in the various professional fields brought together in the Inter-faculty Study Group for Planning, Urban Design and the Environment. Between 1978 and 1980, eight different groups worked, half a year each, on environmental awareness plans for cities like Delft, Rotterdam, Almere and Wageningen. One result was formation of the SOM Group currently acting as the source for co-ordination of regular environmental education. The concept of maximisation is currently used in the design tasks in the second-year block IMAGO (Integration of Environmental Aspects in the Built Environment) and in the fourth-year environmental module '*Integrated Design*' and in the Delft Interfaculty Research Centre: '*The Ecological City*'.

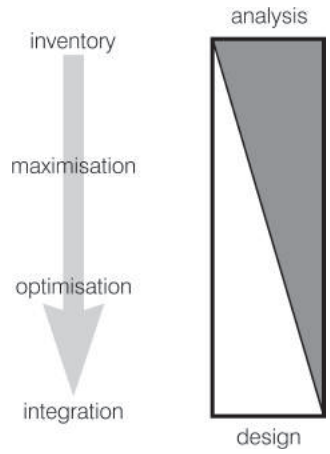
34.3 CONTACT WITH ACTUAL PRACTICE

The SOM Group has many contacts with actual practice; ex-SOM students are involved in the majority of Sustainable Building projects in the Netherlands. One important contact is with *BOOM*, *Buro voor Onderzoek & Ontwerp voor het Milieu* (Office for Research & Design for the Environment) in Delft. In 1995 BOOM completed the manual '*Materials for Sustainable Urban Design*' commissioned by SEV (Steering Committee for Experiments in Housing) and Novem (The Netherlands Agency for the Environment and Energy). This manual and the maximisation concept are being used in the planning of DE Wijk, a 2.800 houses development area in the western part of Tilburg.[a]

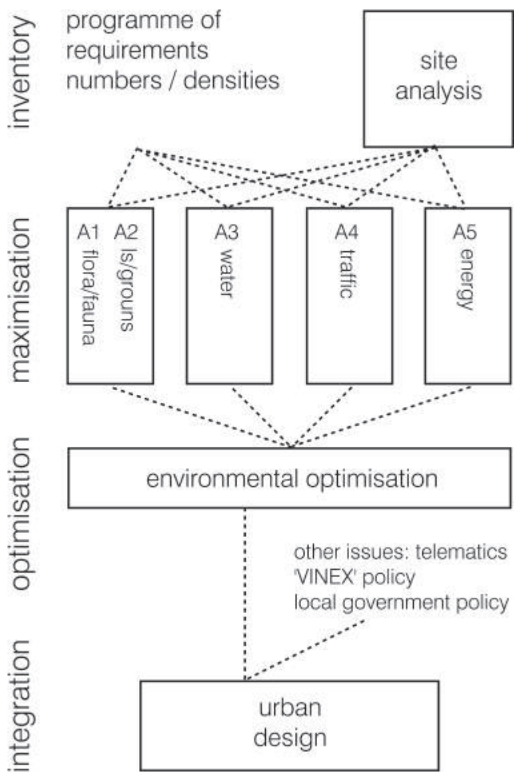
34.4 THE THREE-WAY APPROACH

After brainstorming sessions, the local government departments developing DE Wijk in Tilburg decided to take a three-way approach. Besides design quality and environmental quality research study would be carried out into what influence the application of computer techniques might have on the master plan for the new area. Prof. Wytze Patijn was asked to supervise design quality, Prof. Theo Beckers of Tilburg University was asked to handle informatics and the author of this Chapter was given the task of ensuring that environmental thinking had proper influence on the master plan. In the first instance the local project co-ordinator only

a Boom-Duijvestein (1998) *De mileu maximalisatie methode.*



321 How environmental issues affect the master plan during the gradual progression from analysis to design



322 Maximisations give insight into environmental issues affecting the master plan. Sketch maps are given for the subjects and issues in the boxes. A1, A2 etc. refer to the manual 'Materials for Sustainable Urban Planning'

involved local government departments in the planning process indirectly. This meant that the team that had been put together had the task of developing not only a product (DE Wijk), but also a process.

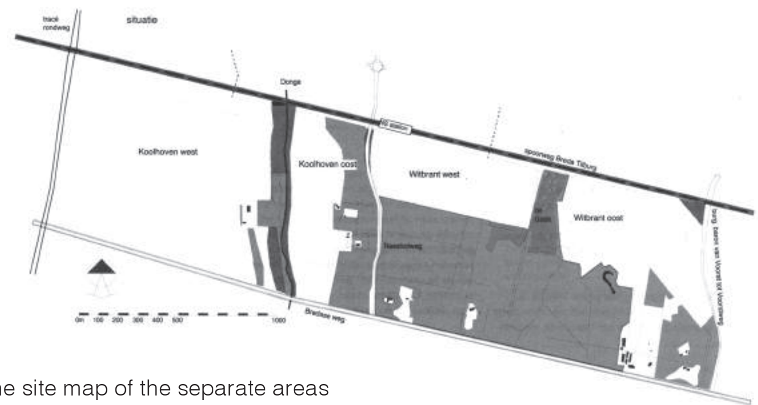
34.5 DESIGN PROCESS

Design processes are often carried out in a highly individual way, which makes it difficult afterwards to find out exactly what happened. The process, from analysis of the location and the programme of requirements through to design, takes place largely inside the heads of those involved. If all goes well, this ensures a constant interplay between analysis and design.

The first draft (design) is often put forward quite early on, and refers back to continuation of the analysis that will be necessary for quite a while. Figure 321 represents the gradual progression from analysis to design as a two-way process. The maximisation concept is used to give some insight into the influence of the environment on the master plan. For each environmental issue a plan is drawn that would be most beneficial to the environment if all requirements relating to that issue, and of course to location and requirements, are taken into account (see figure 322).

34.6 THE SITE

The method used certainly allowed the choice of location and programme of requirements to be analysed, but did not allow it to be discussed in the first instance.

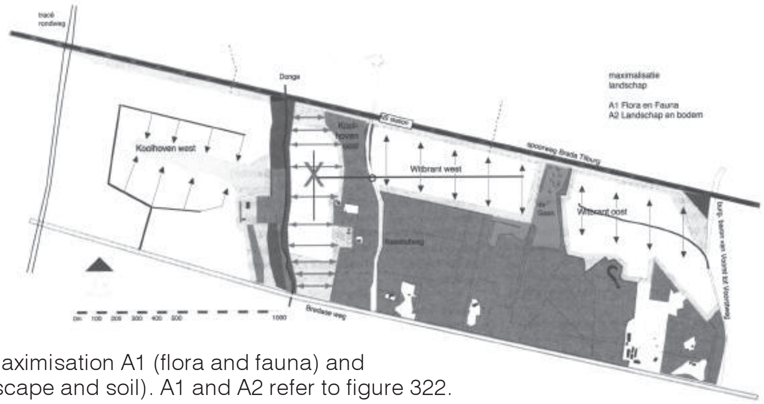


323 Map 1 The site map of the separate areas

The location is due west of Tilburg, south of the 10,000 house district of Reeshof, between the railway line running from Tilburg to Breda and the old Breda road, about eight kilometres from the centre. The programme includes at least 2,650 houses for which the necessary services are to be in Reeshof on the other side of the railway track. The Witbrant district was reserved for the Floriade, but when the choice for Floriade 2000 went to Haarlemmermeer the area came free for residential development. It consists of fields and grazing land where buildings can be put up without trespassing on an area of pine trees within which, in principle, no building is permitted. A number of estates are located in this area along the Breda road. On the east the boundary is formed by the Burgemeester Baron van Voorst tot Voorst road, and on the west by the future western ring road. The area is divided in four sections by a stream (the Donge), the Reeshof road and a piece of heath land (De Gaas). There is a plan for a railway station along the Reeshof road. The area comprising Koolhoven west and Witbrant west is to be connected to the Reeshof by a tunnel for cyclists and pedestrians. All this is shown in map 1.

Landscape

The maximisations A1 (flora and fauna) and A2 (landscape and soil) used the countryside inventory prepared by the local department responsible for the provision of green space. This inventory divides Tilburg into separate regions and gives for each region present an ecological quality and a description of the target to be aimed at.

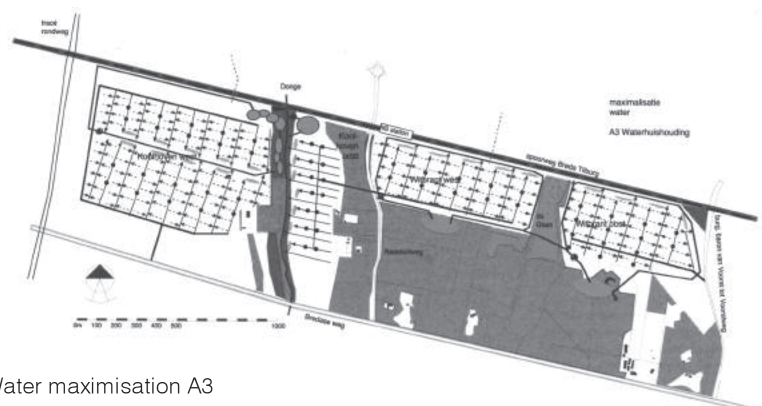


324 Map 2. Maximisation A1 (flora and fauna) and A2 (landscape and soil). A1 and A2 refer to figure 322.

The regions with the highest present and future ecological quality are in DE Wijk the strip along the railway, the heath land (De Gaas) and the area between the Donge and the Woodland along the Reeshof road. This Area, Koolhoven east, is scheduled for building, but should really remain unbuilt, forming an important connection between the Donge and the Wood. The strip along the railway largely co-incides with the noise-pollution zone, so the pressure to build is to be expected mainly in the neighbourhood of the station. Access is to be provided to the edges of Koolhoven west, with an extra strip of green planned for the middle; access to Witbrant east and west is thought to go via the middle. Map 2 shows how these data are translated into a sketch of the master plan.

Water

An important guideline in the water maximisation is that rainwater infiltration should be allowed to the greatest extent possible, topping up the ground water level. This combats drying out and minimises reduction in water quality. So the surrounding natural areas and the quality of the immediate environment will benefit from this maximisation.



325 Map 3. Water maximisation A3

Rainwater from roofs and the surfaces of road not intensively used by motor traffic is either allowed to flow directly into the ground, or led to ditches via surface drainage. Water in the ditches is then pumped back; up to higher sandy areas in the pinewoods. Water still left is discharged in the Donge. Map 3 indicates how this is done.

Traffic

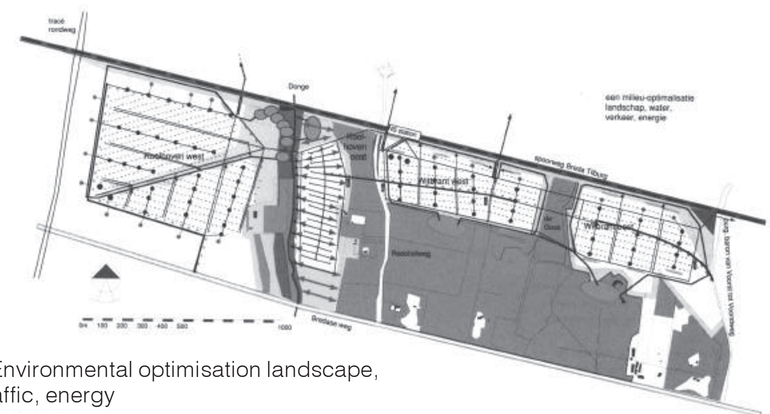
This maximisation looks at cyclists and pedestrians ('slow traffic'), public transport and motor vehicles. Issues relating to cyclists and pedestrians include road safety, connections, immediacy (including access to the railway station, schools, the Reeshof Centre and the centre of Tilburg), speed, attractiveness and the alternatives available at times when the prevailing circumstances create a feeling of social insecurity.

Direct connection with the station means a diagonal running across Koolhaven west. There are connections under and over the track in Koolhoven west and Witbrant west. For public transport the location of the planned station is taken as fixed; further consideration being directed at provision of a fast direct bus route and maximal distance between houses and bus stops. Koolhoven west is to be opened up for motor traffic from the Breda road, Koolhoven east and Witbrant west from the Reeshof road and Witbrant east from Burgemeester Baron van Voorst tot Voorst road. This means that the Donge and the heath land area are not crossed by motor vehicles in any way, though crossing will be possible for the other two types of traffic. Slow traffic and public transport are the key factors in this maximisation.

Energy

Energy maximisation looks primarily at the influence of orientation towards the sun. According to specialists, district heating imposes no pre-conditions that need affect the master plan. Uses of solar energy considered were passive: windows or conservatories, and active: solar collectors or solar cells. In all cases a deviation of no more than 20° from due South appeared to be acceptable. The long straight lines running through the location – the railway line and the old Breda road – which gave the town-planners' outline master plan its name, deviate approximately 15 from East-West. This makes the area outstandingly suitable for East-West land division for the residential blocks.

34.7 AN ENVIRONMENTAL OPTIMISATION

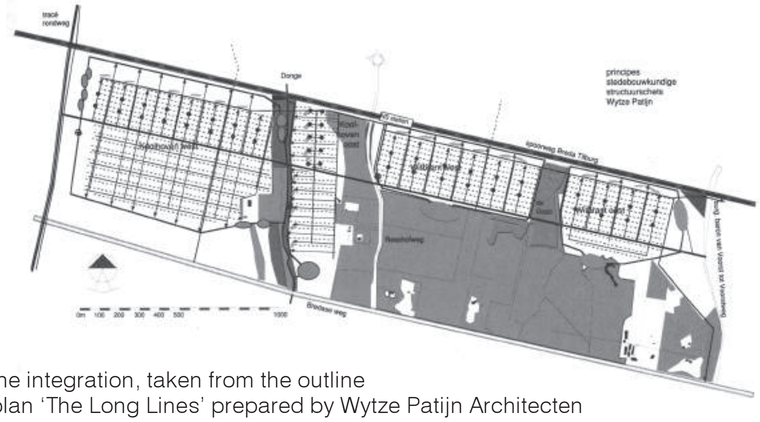


326 Map 4. Environmental optimisation landscape, water traffic, energy

The individual maximisations appear for the most part to fit together well, like pieces of a jigsaw. There are a few points at which choices must be made. The landscape maximisation indicated that Koolhoven east should be left unbuilt, to preserve the connection between the Donge and the higher wooded area. But this area is situated close to the station, and for that very reason should have a high building density. The choice was made to build in the area, but to have green connective zones. The landscape maximisation opened up Witbrant to traffic form the middle of the districts, while the water system and the traffic system provided access along the edge of the wood. The existing landscape has been taken as basis; the other maximisation models have been adjusted to fit. Fortunately, they are sufficiently flexible to allow this.

34.8 THE INTEGRATION

Map 5, taken from the outline master plan 'The long lines', shows how everything has been integrated.



327 Map 5. The integration, taken from the outline master plan 'The Long Lines' prepared by Wytze Patijn Architecten

A large number of points can be recognised as derived from the individual maximisations and the final optimisation. It seems that the different players were in agreement (or reached it) on a large number of matters affecting the master plan. Disagreement remained on two issues. In the outline master plan, the choice was made to introduce a long third line, the *'Nieuwe Laan'*, to accompany the two existing lines (the railway and the Breda road). This *Nieuwe Laan*, a significant visual element, important for the design, connects the various neighbourhoods and also provides access for buses and cycles. How to avoid traffic, using it as a short cut or driving too fast along it, is to be looked at in the detail planning stage. Consideration is to be given to experimental electronic speed regulation systems and perhaps blocking the traffic flow by the Donge and by the De Gaas heath-land. Another immediately recognisable difference between the environmental optimisation and the way everything is integrated into the plan is the absence of a diagonal green strip and a route for slow traffic in Koolhoven west. This is a case where the image of a peaceful piece of urban design took precedence over a short connection for slow traffic. The outline plan does provide a close-knit network for slow traffic that will be almost entirely free of motor vehicles. What will happen next? After the outline master plan was prepared, four designers were asked to give their ideas on how the development of DE Wijk might be taken further. After discussing different opinions, they were asked to concentrate particularly on the individual component areas, while at the same time keeping an eye on developments in adjacent areas.

328 Map 6. One of the variations from the design study carried out by Lafour en Wijk for the consultation with designers in November 1996

Map 6 shows a variation that came out of one of these studies, from which it is possible, to some extent, to see how each individual component area is to be developed in its individual way. It also shows how an attempt is to be made to keep the area between the Donge and the wood as open as possible, both visually and as an ecological connection, despite building. The environmental maximisation method appears to be an outstanding tool for systematic integration of environmental issues into the process of urban design.