A Theory of Integration for Design and Planning Based on the Concept of Complementarity

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By

Trausti Valsson

Dipl.Ing. (Technical University of Berlin, West Germany) 1973

DISSERTATION

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ABSTRACT

The task of environmental design has been dissected into rather isolated disciplines. As a result houses have little connection to gardens and urban areas little connection to landscape areas.

This dissertation outlines a theory of unification, aimed at spatially connecting and functionally interrelating environmental areas. The method developed to achieve this goal is based on form-principles, i.e. four types of spatial arrangement that can be applied in the planning of the areas' interface, i.e. in the way this zone is laid-out and shaped.

How the four form-principles contribute to unity and integration can be summarized: (I.) The Circle -- If adjacent areas (e.g., of land and water) come close to a circular form, the unity of the two is enhanced. (II.) The Dynamic (concave/convex) line -- The unity of adjacent areas is enhanced if the line between them is formed in such a way that it interlocks them. The concavities and convexities, created by such a line, also provide spatial situations useful for the accommodation of certain ecological and human activities that help interrelate land and water areas. (III.) Complementary features -- This principle contends that "opposite" features, if carefully matched, complement and

mutually enhance each other. (IV.) Cores of the opposite area -- The connection between two areas is stronger if a core from one of the two is located in the other and vice versa. -- All four principles are rooted in the concept of complementarity.

To investigate the application of these principles in planning, the history of changes in form and changes in functional interrelationships between land and water at the North Coast of Reykjavik, Iceland, have been studied. The case studies conclude that a link exists between a strong presense of the four form-principles and a strong presence of interrelating ecological and human activity in the same area, or conversely that weak form qualities correlate with a weak presence of interrelating activity.

Michael Lauri

Chairman of the
dissertation committee

Foreword

The origins of this work goes back to my study years of architecture and planning at the Technical University of Berlin, West Germany. I finished my diploma thesis there, on morpholgy and methods, in 1973.

During my years as designer and planner in my hometown Reykjavik, Iceland, my ideas on world views and their relation to structure and order was advanced in discussions with the designers E. Th. Asgeirsson and K. Jonsson. Also visits and discussion with the famed American designer R.B. Fuller was of great help.

Soon after I came to Berkeley in 1980 I formed a discussion group on my research interests with three countrymen of mine living in the Bay Area: Composer Th. Hauksson, biochemist H. Kristjansson and engineer H. Loftsson. Discussion with mathematician S. Thormar, planner T. Priestley and designer J. Koh were also of great help.

Faculty of the University of California, Berkeley, who have been involved in my work are: from the Philosophy Department: P. Feyerabend, and from the College of Environmental Design (in alphabetical order): C. Alexander, R. Bender, T. Dickert, A. Dubovsky and R. Twiss.

The members of my dissertation committee are, however, the ones that have put most work into my dissertation. They are: P.E. Groth, an architect and geographer, who has expanded the cross-cultural scope of my work. G. Cranz, an

architectural sociologist, has helped me through the use of operationalism to make my concepts more concrete. Most indebtedness I owe to the chairman of my committee M. Laurie. His expertese on Oriental and visual matters, together with his sure intuitive sense of where I was going right or wrong, have proved to be crucial for this work. My best thanks to them all.

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INTRODUCTION

1. The paradigmal flaws of modern design as discussed in the design literature

Many authors on design theory have expressed a dissatisfaction with the paradigm of modern design and many writers on science and philosophy claim that today's paradigm (cosmology) is flawed because of e.g. too much fragmentation and too little awareness of what role time can have for concepts and processes.

Only few authors on design are educated in cosmology, ontology or the methodology of science so in cases where they have tried to link the problem of modern design to the governing world view, they have been hesitant and insecure. The discussion on paradigms in the design literature is therefore too unformulated to use in my discussion of world views in the first part of the dissertation: Philosophical Background. In my discussion there (Ch. 1, sec. 2), I report on the shift in world view that is now taking place, as it is described in books on the philosophy of science, on quantum physics and on ecology. I also show a parallel of these ideas to Oriental theories and to theories in art on complementary forms and colors.

Two of the flaws of today's world view,--i.e. the lack of sense of time and the fragmentation--have found their way into the design literature. "Active time" has proved to be a

tangible concept for the authors, but the "fragmentation" has been too difficult a problem to allow theorists to point out practical approaches or remedies.

E. N. Bacon explains the contribution of his design theory in the following way at the end of his book Design of Cities (1967):

> In this book we have discussed movement, the time dynamic, and change... (p. 322).

As a future outlook, however, he contends that:

> The test of our achievement is whether we are able to break away from our fragmented approach to this problem and begin to see the city as a whole, dealing with it as a complete organism (p. 322).

Bacon does not offer solutions but refers to the visual arts:

> Here, again, we may listen to the words of Paul Klee: 'Accordingly, a sense of totality has gradually entered into the artist's conception of the natural object....and the first consequence is that a more spatial conception of the object as such is born'... (p. 322).

The visual arts have frequently been the main path towards understanding the ontological nature of the problem. R. Arnheim, a professor of the psychology of art, has done extensive work on this, among other writings, with the books, Art and Visual Perception (1974) and Visual Thinking (1969). In Dynamics of Architectural Form (1977) he transfers his theories to the realm of architecture. In the first chapter of the book he relates the fragmentation to modern self-centered attitudes:

> ...That is the sort of disconnected treatment to which we owe the visual, functional, and social chaos of

> modern life. It derives from the tunnel vision employed for immediate practical ends, especially under social conditions that atomize the human community into mere aggregate of individuals or small groups each minding its own business. (p. 17)

C. Rowe and F. Koetter, in Collage City (1978), see the singular world view leading to utopian thinking, and in a hesitant way trace it to theoreticians of the 17th and 19th century:

> There persists an eighteenth century belief in the veracity of science (Bacon, Newton?) (They are 17th century scientists TV) [sic.], and an equally nineteenth century belief in the veracity of the collective will (Rousseau, Burke?) [sic.]: and, if both of these can be conceived to be furnished with persuasive Hegelian, Darwinian, Marxian overtones, then the situation rests, almost as it rested nearly one hundred years ago. (p. 8).

Rowe and Koetter argue that today's rejection of this view will lead to the fall of utopian and idealistic schemes for cities: They help their argument by referring to the "reconquerance of time" and the resulting awareness of the historic dimension of cities.

In their book Rowe and Kotter demonstrate that different parts of cities get built in different periods of time--and thus that these parts, therefore, have different characteristics. The result is a city that on a map looks like a collage picture--and thus the name of the book Collage City.

S. and J. Jellicoe also look for metaphors within the visual arts in their work on The Landscape of Man (1975). They e.g. quote A. Ossario on the value of the paintings of J. Pollock as a model:

> His paintings confront us with a visual concept organically evolved from a belief in the unity that underlies the phenomena along which we live. (p. 343).

The Jellicoes--as so many design theorists--see ecology as a model for the mending of our fragmented world:

> The union of abstract thought and natural form as a concept of art has been axiomatic in history. The revolution of knowledge at the beginning of the twentieth century abnormally separated the two, but with the growth of the ecological sciences, the concept is returning as a fundamental basis of landscape design (p. 366).

K. Lynch shares the organic, holistic view of the Jellicoes' in his book Theory of Good City Form (1981). He says:

> It is crucial that we come to see ourselves as an integral part of the total living community. Above all, perhaps, it is this holistic view which is the most important contribution of organic theory (p. 98).

The main effort of Lynch's book goes to explain where the theory of city-form stands today and to state the main requirements to a future theory that yet does not exist. He sums up:

> ...we have no adequate contemporary normative theory about the form of cities. There is dogma and there is opinion, but there is no systematic effort to state general relationships between the form of a place and its value (p. 99).

The following is an abbreviated list of performance criteria for a form-theory that Lynch publishes in his book. The list may be of help in the assessment of the performance of my form-theory as aspects of it have been tested with the case-studies:

> ...a set of performance criteria should have the following characteristics:

> 1. They should be characteristics which refer primarily to the spatial form of the city....
> 2. The characteristics should be as general as possible, while retaining their explicit connection to particular features of form.
> 3. It should be possible to connect these characteristics to the important goals and values of any culture...
> 4. The set should cover all the features of settlement form which are relevant...
> 5. The characteristics should be in the form of dimensions of performance...
> 6.Locations along these dimensions should be identifiable and measurable....
> 7. The characteristics should have the same level of generality.
> 8. If possible they should be independent of one another...
> 9. Ideally, measurements on these dimensions should be able to deal with qualities which change over time... (pp. 112, 113).

In his book Lynch tries to outline a form-theory based on 1.) Vitality 2.) Sense 3.) Fit 4.) Access 5.) Control and 6.) Efficiency and justice. He is encouraged by his studies but contends that his theory is still inadequate, as can be seen in the end of his epilogue:

> There is much to be done, which is a blessing. A useful, intellectually engaging theory of city-form is quite possible (p. 324).

The four appendixes of the book try to understand the inadequecies of today's theories. In a review of the shortcomings Lynch says under #4:

> ...many of the important spatial features of cities are left out....Almost nothing can be learned about the actual experience of the place...There is still another persistent problem. While standard descriptions agree on emphasizing human activity in its relation to physical form, they are prone to confound the two in a single ambiguous description... (pp. 348, 349)

Lynch's honesty about his frustration about his own and others' theoretical attempts are disarming, and his honest

confessions identify valuable notions on the most difficult, and at the same time, most crucial criteria. He says:

> That urban theory is so boring is more than discouraging. It must be a sign of deeper difficulties....One wonders about their adequecy as general rules, and whether they truly embrace the interrelation of human purpose and city form. (p. 343).

2. Concepts within a new paradigm and a discussion of aspects of it in the literature

The roots of dissection are commonly traced all the way back to the ancient Greeks. Funk & Wagnalls New Encyclopedia (1983) describes this in the following way:[1]

> Plato has his hero Socrates make a new, shattering distinction, between many 'things' and a single 'idea'... (p. 9)

This split of one reality into things and ideas, object and subject, being and place, appears in many versions in design, such as in the division into form and function approaches, and the division of environmental planning into urban planning and landscape planning.

Many modern philosophers have tried to mend the dualistic split. For example, the following exerpt shows how M. Heidegger (1971) uses etymology to support his suggestion that the word dwelling (being) is actually rooted in a place:[2]

> The Old English and High German word for building, buan, means to dwell. This signifies to remain, to stay in a place. The real meaning of the verb 'bauen,' (in German) namely, to dwell, has been lost to us. (p. 146)

A common term (but not the only term) on this in philosophy is the subject-object duality split. Cultures that only suffer this split to a low degree are often called holistic. They are characterized by their non-dissective, i.e. integrated approaches to things. Rifkin (1980), Prigogine, Stengers (1984). Guided by the holistic philosophical principles of the Chinese T'ai Ch'i I have outlined a design theory that can be helpful in the interrelating and integrating of the elements of design.

The first two chapters of this dissertation attempt to briefly explain the philosophical theory. To illustrate the application of the four philosophical principles of complementarity as they appear in the T'ai Ch'i, the study focuses on a specific problem area in planning. The treatment of this problem area has two parts: a theoretical section, which explains the concept of complementarity and its four form-principles, and an empirical section, which tests whether the four priniples are valuable in connecting and interrelating an urban area and a water area in Reykjavik as judged by levels of biological and human acitivity.

In 1978, J. Koh wrote a theoretical dissertation, on the nature of three of the principles (I. unity, II. dynamic balance and III. complementarity), symbolized respectively by I. the Circle, II. Yin-yang (a dynamic line) and III. T'ai Ch'i (complementarity). Koh's dissertation included case studies demonstrating how these principles have contributed to the conception of significant modern

architecture examples. Koh's main concern was to demonstrate the links between these Oriental principles and modern ecological principles. He called his dissertation and the design theory that he created on the basis of them; An Ecological Theory of Architecture (1978)[3]. He has extended upon this work in his subsequent works (1983, 1984)[4].

In ecology, wholeness (Principle I) can be seen in the unity of organism and place, and dynamic balance (Principle II) can be seen in the dynamic adjustment of the two. Koh was influenced in his dissertation by the work of one of the members of his dissertation committee I. McHarg. McHarg's book on the subject, Design With Nature (1969)--i.e. wholeness of a design and its natural environment--, has had an important influence on the use of this model in design in the United States, primarily in the 1970s.

E. Relph explains the lack of the wholeness of people and place in his book Place and Placelessness (1976). This book is a revised version of Relph's dissertation in geography so it is more an analysis of the problem than a design concept which deals with the creation of a wholeness out of people and place in design and planning.[5] Some of the chapter headings give an indication on Relph's approach: "Place and the phenomenological basis of geography," "The essence of place" and "On the identity of places."

Relph's book is one of many books in recent years that tries to explain what phenomenologically gives an urban environment its character, its identity (as concerns visual

features). Once this typical identity has been defined the designer has gotten helpful guides in his quest to let design fit into the character of its context. A well known book on the subject but more form related because it is by an architect, is Genius Loci: Towards a Phenomenology of Architecture by C. Norberg-Schulz (1980)[6].

A Pattern Language by C. Alexander et al. (1977), which is a catalogue of successful design elements or phenomena, can be seen as being related to the phenomenological approach of Relph and Norberg-Schulz. Alexander's does, however, not state as an explicit goal to seek out patterns that fit to some place- or culture-specific context.

In a book based on interviews with him: Christopher Alexander: The Search for a New Paradigm in Architecture by S. Grabow (1983), Alexander explains that he is searching for a geometric structure that constitutes a complete wholeness. Alexander suggests twelve forms or form-properties that are necessary to reach a wholeness in design (examples of the properties: center, hierarchies, local symmetries). He is now writing a book on the subject with the worktitle The Nature of Order. Alexander sees this as a further synthesizing step in his work on patterns.

One of the first attempts by D. Appleyard to make designers aware of the lack of wholeness-understanding of the link between the environment and its social meaning was the essay "The Environment as a Social Symbol: within a theory of environmental action and perception" (1979). Appleyard

starts his paper by declaring: "Both design professionals and social scientists tend to screen out the connection between the physical environment and its social meaning."

Identity, Power and Place, is a manuscript Appleyard's tragic death in 1983 left unfinished[7]. In this work he makes use of social psychological formulations from the work of E. Erikson (1959). In this way Appleyard has outlined a theory on design that begins with a definition of the "elements" that an individual must possess to enjoy a mental wholeness, a mental health.

Another body of literature relates specifically to three of the principles i.e. to I. The Circle, II. Yin-yang (concavity/convexity) and also to III. Core of the opposite. Because these terms constitute basic geometric or topological properties, discussions on them surface frequently in the literature on design and visual matters, as well as in writings on the symbolism of forms and the psychology of perception. To narrow my project down to manageable scope I decided to focus on the functional aspects of the principles, excluding the emotional and aesthetic qualities.

Writings on the symbolism of forms appear, however, in Chapter 3 on the four form-principles; writings on the aesthetic aspects of the principles are briefly discussed in Chapter 4, section 3 which deals with the various form-properties of the four principles.

Books, geometric or topological in nature, will enter my discussion of methods in mathematics that are of help in the

study of functional and general qualities of form (Ch. 4 sec. 1 and 2). A few of these are Principles of Mathematics (1963), A Primer of Visual Literary (1973); Symmetry (1962) and Laws of Form (1969).

One might assume that a theory on the basic functional properties of forms in a city already exists. This, however, is not the case. Elaborations in the literature on form in city planning, has primarily been dealt with in terms of the forms' stylistic, symbolic and organizational value. K. Lynch, explains in A Theory of Good City Form (1981), the current status of these matters.

> The study of cities has no powerful basic language of its own. It borrows devices of geography and architecture, but they are only partly useful.
>
> If a language particular to cities develops, it is likely that it will be a graphical one, since graphics are superior to words. (p. 351)

Lynch speculates on what might become the prime means of such a language:

> Graphic diagrams, with words appended are the prime ways of conveying these shapes. Mathematics are steadily becoming more important for doing so particularly by the means of topology since many of the spatial relations in settlements are nonmetrical. (p. 257)

The field of topology that Lynch mentions, has relations to my form-principles. What these relations to topology in mathematics are, is discussed in Chapter 4 section 1 and 2.

And Lynch continues his vision of a future form-theory:

> Insides, outsides, connectedness....and density are form-concepts likely to be more critical than such geometrical analogues as square, triangular and round. (p. 357)

All the form-concepts that are listed here as critical constitute important properties in the four form-principles discussed in this thesis.

The principles all deal with increased connectedness and integration. Principle I (the Circle) is, per definition, the densest packing of elements, and principle II (concave/convex line) and III (complementarity) deal with an enhanced connectedness between such polar pairs as insides, outsides and land, water. Only few books on urban and landscape planning deal constructively such interrelations or with the interrelation of specific areas, such as land- and water-areas. The reason for this is that in today's dissectionized organization of the design field, books and theories deal primarily with the isolated elements of the environment but theories on how to interrelate and connect these elements are largely missing.

Two of the patterns of C. Alexander's A Pattern Language (1977) have something to say about the interrelation of land and water. The guidelines given in pattern 25 "Access to water," are as follows:

> When natural bodies of water occur near human settlements, treat them with great respect. Always preserve a belt of common land, immediately beside the water. And allow dense settlements to come right down to the water only at infrequent intervals along the water's edge. (p. 137)

The pattern is sketched in a diagram from the same page.

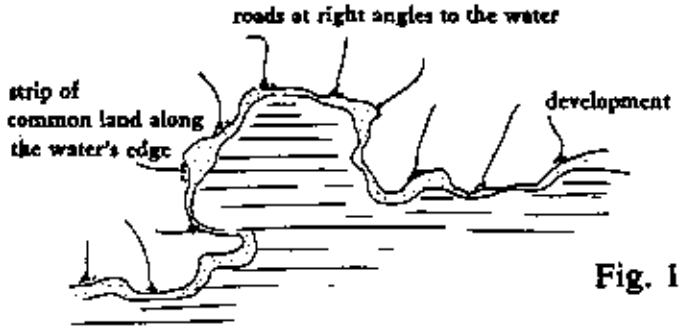


Fig. 1

The psychological need for a connection to water is postulated in the following way in pattern 64 "Pools and streams":

> We came from the water; our bodies are largely water; and water plays a fundamental role in our psychology. We need constant access to water, all around us; and we cannot have it without reverance for water in all its forms. But everywhere in cities water is out or reach! (p. 323)

Earlier in the book Alexander refers to Jung as he explains the importance of water:

> ...the need that people have for water is vital and profound. (See, for example, C.G. Jung, *Symbols of Transformation*, where Jung takes bodies of water which appear in dreams as a consistent representation of the dreamer's unconscious.) (p. 136)

The Chapter "Some reflections on space" in the book The Aesthetic Townscape (1983)[8] by Y. Ashihara discusses aesthetic qualities of some coastal towns. These will be mentioned in Chapter 4 section 3.

Ashihara ends his section on coasts in the following way:

> In Tokyo Bay and many similar locations around the world, artificial land is being created by landfills

> jutting out into bodies of water. Today, I believe, we have reached a stage where the civil engineers who direct these projects should give careful thought not only to function and efficiency but to aesthetic qualities, and they should strive to incorporate curved landscapes and other features that will improve the appeal of the scenery they are creating. (p. 110)

The first book discussed in this study of the literature was the dissertation An Ecological Theory of Architecture by J. Koh (1978). This dissertation formulates the theoretical background of the principles but the case-study section is brief (25 pages) and Koh does not use the direct topological properties of the principles as I do in my case-studies. How Koh uses the principles to explain the validity of his cases is, however, of interest for comparison. The following example is his analysis of F.L. Wright's house "Falling Water". (See fig. 2).

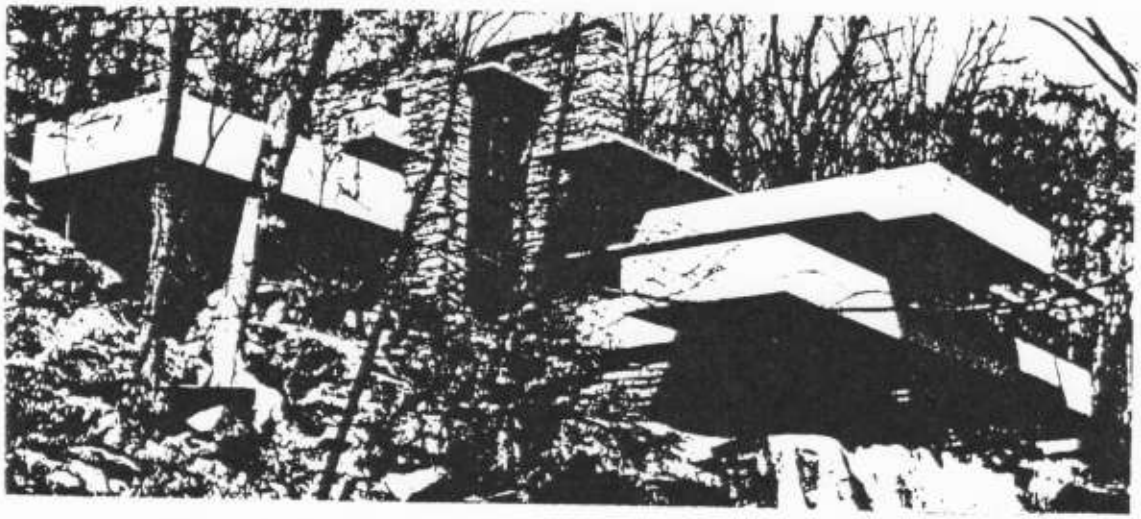


Fig. 2 Strong integration of a house and its environs

Koh explains this design in the following way:

Unity: Falling Water does not have a hierarchical nor a symmetrical organization. Its formal unity, therefore, stems from the dominating cantilever and the natural stone walls. It is identified with the place. The structure is directly set on rock. Local stone is used throughout. The stream's falls are integrated as part of the house. A strong visual continuity of space exists between inside and outside.

Dynamic Balance: The dynamics of the building is achieved by a bold cantilever structure, contrasts between painted stucco cantilever mass and natural stone walls, and a fluid space.

Complementarity: The "mass" and "space" are complementary to each other as are the house and landscape. The landscape is felt indoors by exposure of rock outcrop and visual extensions to the outside. (p. 257)

My theory and my case-studies deal with the effect of the principles in planning (i.e. in a two-dimensional plane), and therefore the two-dimensional properties of the form-equivalents of the principles (Circle, Concave/Convex line, Complementarities and Cores), are of much more direct influence than in such architectural examples as Koh on Wright.

As I indicated earlier, my work extends Koh's theory as concerns the mathematical and topological properties of the principles. My study of books on Oriental art and design identified several instances where the form-principles appear directly[9]. Although this is not of direct relevance in the present work, this may be of a general interest to the reader. See the following illustrations:

I. The Circle

II. A Dynamic line

III. Complementarities

Fig. 3

Fig. 4 gives an overview of what form-features correspond to the three principles. A special contribution of mine is the addition of the fourth principle of the T'ai Ch'i symbol to the theory (identified by IV). This principle will be explained in the Theory Building section which comes after the following Philosophical Background section. My main contribution is, however, the demonstration of a link between these form-qualities and interrelating, unifying qualities.

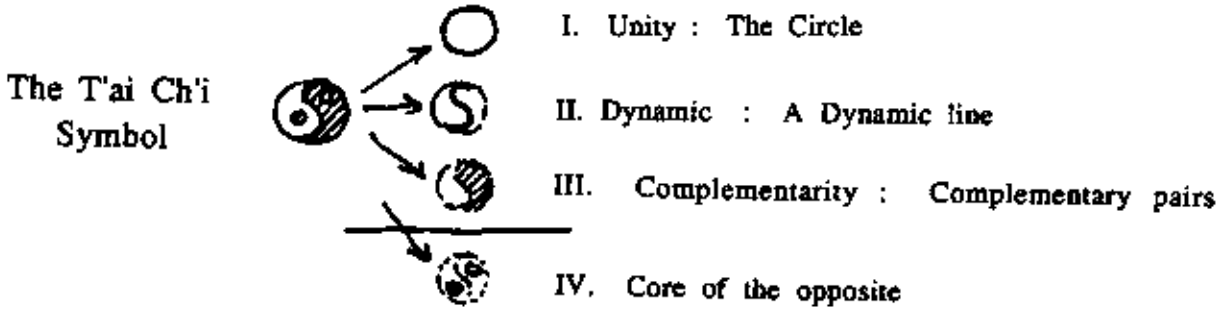


Fig. 4

I. PHILOSOPHICAL BACKGROUND

CHAPTER 1: Disconnection, and its roots in the dissectionized worldview of today

1. The motivation--and examples of the dissectionization in modern societies

The motivation that led me to do this work was my dissatisfaction with the lack of physical connections in modern design, and the resulting functional and emotional alienation. My basic conclusion from this theoretical work is that one of the roots of this problem is in the compartmentalized organizational schemes governing in today's world view. Writings, from the philosophy of science (Feyerabend, 1975 and Rifkin, 1980), helped me understand the early developments--primarily within the methodology of science (notably in the 17th century: Bacon, Descartes, Newton, etc.)--that led to the rise of the dissectionizing model in our Western world. My inquiry also helped me understand basic characteristics of the holistic world view.

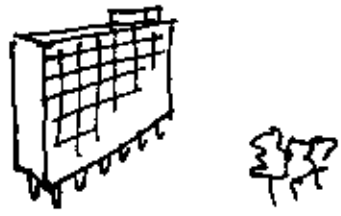
The method of dissectionizing, cutting subjects into isolated aspects, became successful in science, and gradually this method also became the way to approach things in other disciplines. Because this mechanical scheme was so

successful, people's value systems started to be influenced by it, and a general attitude and an aesthetic taste developed that preferred things that were securely separated (Read 1965, Koh 1978).

One of the clearest examples of this is the strict zoning in land-use plans, where the goal is to separate and even isolate the various functions in the city like: living, playing, working--in specially assigned areas (this approach, however, has increasingly been criticized in recent years by writers who opt for social integration).

Planners, politicians, designers have frequently seen their mission to "straighten peoples' lives out" in this way, and have had little appreciation for the "messiness" of the organic interweaving of functions in cities and neighborhoods that were evolved naturally.

The two areas that I have studied the most, is how a house and garden, and a city and its natural environment (land, water) meet and relate to each other. In my presentations, I often put good and bad examples side by side in the illustrations to make the comparison clear, as in the two upcoming pictures. The first picture shows how a modern designer (Le Corbusier) has a tendency to isolate the inhabitants from their environment (e.g. by putting the house on pillars). The diagram to the right shows, as a contrast, how in a Japanese house the integration of the inhabitants and their surrounding environment is aided by the way the house and the garden are designed.



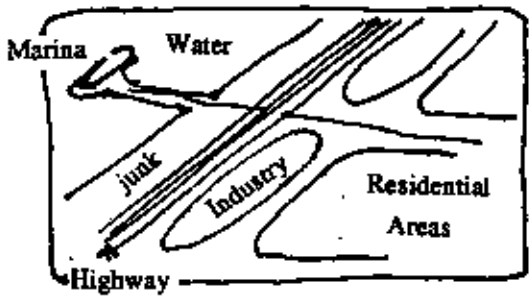
A. Seperating of a house and a garden

B. Integrating of a house and a garden

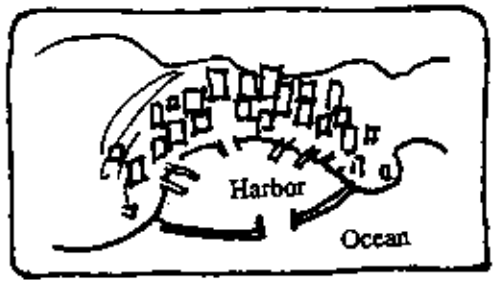
Fig. 5

Within my view, that sees a contact of inhabitants of houses to their environment as positive, Corbusier's idea to put an apartment building on pillars is "bad separatedness." In cultures, however, that live in a dangerous environment, the idea of putting houses on stilts can sometimes account for a "good separatedness." Dangerous features in an environment could be wild animals, insects or flooding.

The next picture-pair shows how in city planning, an urban area interrelates, or does not interrelate, to an adjacent body of water. The picture to the left shows how little contact the urban area in Berkeley, California, has to its coastline and the beautiful San Francisco Bay. With the exception of the marina, the city is designed as if it were nowhere close to this wonderful resource. The picture to the left shows, as a contrast, how the interrelationship between the city and the water, in a typical Italian coastal town, gives the town and the life in it its charm and contact to the reality of its environment.



A. Seperation of the water and the urban area (Berkeley, California)



B. Integration of the urban and the water-area (Italy)

Fig. 6

The interrelationship of an urban area and the water area of the North Coast of my home town Reykjavik, is the subject of this dissertation's case-study. Specifically this is a study of what role the four form-principles play in the interrelating of land- and water-areas. Some of the form qualities--such as many of the concavities, convexities and cores--have largely been lost in the course of this century. At the same time--as my study will show--a great decrease in the interrelating between the inhabitants of Reykjavik and the shore and the water has occured.

2. Historical roots of the dissectionizing paradigm, and how new concepts in science and philosophy are recognizing its flaws

To a large degree, the dissectionizing paradigm has its origins in the seventeenth century, in the work of a few thinkers that now, more or less, are seen as the architects

of the Western scientific world view: Bacon, Descartes, Newton, etc.[10] Bacon's Novum Organuum published in 1620, lays out the mental framework that the natural sciences were to apply in their inquiry. The main characteristic of the method is to limit oneself strongly to quantitative data, eliminate all scruples about how this data was acquired and make a judgement about a phenomenon solely based on what can be measured about it. These principles later came to result in ignoring the feeling-aspects of things, including: beauty, spirituality, identity.

One of the undesirable results of the positivistic attitude was that the link between funcitonal and spiritual things was broken, for within the mechanical world view, no concept exists that unifies these aspects. They are by many considered to be totally unrelated. It follows, for instance, that many people do not understand fully that an ethical responsibility is linked to how one shapes the environment. Cultures of earlier times frequently saw work not well performed a disgrace to "God" (to a "unifying principle").

In the Orient the unifying principle was less theological in its nature than in the West. The respect for the laws of nature, that people saw at work around them, was rather what made people respectful of the totality of a situation. These laws are similar to laws on relationships that seem to be emerging in today's science, e.g. laws that recognize the complementarity of mind and body; laws that

will lead to a revolutionary reconstructing in the understanding of society and design.[2]

Newton was one of the principal architects of the positivistic paradigm. His laws on the nature of things dealt only with the relationship of mass, force and speed. Time as an active parameter was not dealt with. Even Einstein, who in his work depended heavily on the observation of a difference in the time it takes light from a star to reach Earth given two spatial situations, did not have a proper understanding of time.[3] The result is, that even to this day, time has not been taken seriously in Western science.

In modern physics and chemistry a dramatic change has, however, taken place in the last decade. Among the new theories, the importance of the direction ("arrow") of time is recognized in certain natural processes. A quotation from Order Out of Chaos (Prigogine, Stengers, 1984) gives some insight into this:

> Reversible processes do not know any privileged direction of time. But there are also irreversible processes that involve an arrow of time. If you bring together two liquids such as water and alcohol, they tend to mix in the forward direction of time... (p. xxvii)

Another factor clarifying the basic importance of time is a more proper understanding of the Second Law of Thermodynamics. This law indicates that, every time work is done, the amount of available energy within our solar system is decreasing.[4] In scientific terms, this is expressed as a

tendency towards entropy--i.e. a tendency which can be interpreted as a force towards evening out of all differences (e.g. differences in topography and temperatures) and thus to an absence of energy. This means that the universe is like a machine that is running down. If this is taken directly, this is a bleak outlook as a world view.

In the last decade, entropy has often been interpreted as the negative, destructive tendency in nature that represents a contrast to the constructive force of creation and life. This view, for instance, is reflected in the two opposed tendencies in modern art--i.e., the one towards an extensive simplicity and the other towards dissolution and disorder (R. Arnheim in Entropy and Art, 1971).

Recent scientific discoveries suggest that the solely negative interpretation of entropy (and positive interpretation of order) is wrong. Contrary to this, life and creation are now seen as being dependent on the dynamic interaction of entropy and order--"order through fluctuation" as Prigogine puts it.[5] In this view, all creation is seen as process. In this process orders are created--but orders are also destroyed to allow for a change towards a better fit--i.e.; both the ordering and the watering down of order, are seen as necessary aspects of a self-organizing process.

Some writers say that life-processes like these have an inbred tendency to a higher order (Gowan 1980, Gombrich 1979), but others say that this process is solely aimed at adaptation to a changing environment (McHarg 1969, Koh 1978).

In some cases adaptation could mean that a better fit results in a development towards a lower degree of order.

If we should wish to make this objective of adaptation totally ruling (like dogmatic, prescriptive ecological design theory does) no pushing towards a higher order and higher level of understanding would take place. I personally dislike these "survival" and "equalizing" tendencies of today and would like to see cultures develop again towards superior qualities in art and design.

The realization of the arrow of time and the complementarity of entropy and order (although taken from the natural sciences) need not mean that we equate man with other organisms in Nature. Obviously man can do these two things simultaneously--i.e.; work intelligently in harmony with the laws of Nature and at the same time set his goal towards cultural qualities.

The functionalism of today that uses a phrase coined in 1901 by the well-known American architect L. Sullivan: "form follows function" (S. Langer's Feeling and Form, 1953) is used by functionalist as an excuse not to include order- and form-criteria in the initial stages of a design program. Koh's reformulation of this phrase "form does not only follow form but also environment" (1984) extends today's functionalism to an ecological functionalism.

The present dissertation will demonstrate that in many cases "functions follow form," which makes clearer than has been, that form is not meaningless formality as e.g. the

phrase "mere form" indicates. A conclusion from this is that form can be used to reach functional ends and should therefore be formulated as such in the initial stages of a design process.

One of the goals of this section has been to explain how new ideas in science, such as the direction and activity of time, are fundamental in the construction of a new world view. As modern science has been used to explain that time is active and has a direction, we understand that today's mechanical and static world view is flawed. As the mental blocks of static time have been removed we can, in design, deal constructively with the various phenomena that lead from the active, dynamic nature of time--phenomena like; change, growth, cycles and processes. The design theory of this dissertation works within this conception: the interrelation of land- and water-areas is seen to be dependent on interrelating activities, i.e. we are not merely dealing with a static land-use plan but rather are we going to study connecting activities in a land/water interface and dynamic relationships between areas.

CHAPTER 2: The philosophical and ecological concepts that form the basis for a theory of integration

1. The mind/body split and how it came to reduce people's ability to work with binary aspects in a complementary way

To understand better the nature of complementarity, a study of how its opposite principle, the separation of mind and body (dualism) came into being, will prove to be useful. As I explained in the last chapter, Bacon's demand of accepting only quantitative data became popular among Western scholars. Descartes formalized this principle comprehensively in his Discourse on Method (1637): "...it gradually came to light that all these matters only are referred to mathematics in which order and measurements are investigated..." To be able to investigate in this way, he obviously had to proclaim that matter (body) and spirit (mind) were totally independent identities, as he did in his atom theory.

This makes things more manageable, but this has also meant that people have largely lost the sense of how these two aspects are connected. In city planning this approach, means that the function and the form of a city and its environment are often dealt with separately.

The relatedness of the two complementary elements is quite evident in some cases, as for example in the case of

figure/ground, letter/page, house/garden, or urban/rural.[6] Secondly it is also obvious that many such attributes affect each other, in spite of their seemingly "opposing" nature: hot/cold, good/bad, and as long as their status as relative points within a reference system has not been realized they are called contrasts.

Thirdly, in such fundamental terms as matter and energy and time and space in physics, one at first would not think that they have a binary relation. It was not until Einstein's theory on the complementarity of matter and energy that this deep level of complementarity in the nature of the world began to open up to Western minds. Another revolutionary discovery on these matters is the complementarity of time and space, particularly in subatomic- and astrophysics. In addition, in neuro-science, scientists have found increased evidence of the complementarity of mind and body and rational and intuitive thinking.

To work with these binary elements in an integrated and a mutually complementing way (i.e. not separately), is especially important in design, because the task of the designer is to bring together rational (scientific, functional) and intuitive (feeling, form-related) requirements in his synthesis. Today's education and model of the world, however, makes this difficult.

The fundamental nature of complementarity is finally in the process of being clarified in the natural sciences, as was explained on the previous page. For a further

clarification a look to the East is useful. Their philosophical and religious scholars never accepted the division of mind and body, and through a long and an intuitive process they developed theories on the binary complementarity of almost everything. Many of these theories have been proven empirically useful (e.g. acupunture). The Orientals, however, have been able to rationalize and verify these theories to only a small degree (Koh, 1978). Only recently have scientists started on the way to construct what many of them claim to be a unifying theory on the nature of things.[7]

That this has so much importance for design will gradually become clear in this thesis. One of the fundamental aspects about how this works, is illustrated as a continuous dance between birth and death. This is being rationalized with a theory in physics that claims that everything (atoms, protons, solar systems, etc.) goes through this cycle.[8]

The main characteristic of the creation-phase in such natural philosophical concepts is a process that leads towards higher and higher levels of integration and which finally culminates in the birth of the "it." Then the phase of deterioration, disintegration starts, which finally ends with a total disintegration and death. And at the end of this, a new process of creation can start. That we intuitively sense that these things are at work around us can be seen in the fact that we call new things (like babies and

cars) the "it," and later we start to call them he or she. The term "new," though, is actually not the issue although this quality often appears with new creations.

In nature, creation of new lives happens in the union of complementary male and female elements in some type of intercourse. This act has an air of deep importance about it. Truly original creation in design has the same characteristics: elements or ideas that to an untrained person have seeminly little in common, or even affect some people as being unreconcilable opposites, filled with tensions, are to the master-designer complementarities, that when brought together, create a new exciting unity and harmony.

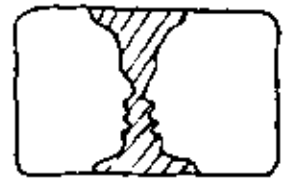
2. The one-sided vs. the two-sided view of the world

Theoretically and philosophically two fundamental aspects have to be understood to realize the nature and the importance of this dissertation. The first aspect is the binary (two-sided) nature of the world that is not included in one-dimensional paradigm, and the second aspect is how and why binary pairs are complementary and mutually enhancing to each other, if they are allowed to work together. This section will discuss and explain the binary-nature and how an approach based on binarity differs from today's way of dealing with things. Examples will be given on what can be accomplished by applying binary pairs in design. The mutual

enhancing of complementary (binary) pairs will be discussed in the next section.

Let us now start this study of the binary nature in quite practical terms by looking at the difference in how one perceives form within today's one-sided vs. the coming two-sided binary world view. The best way to understand this difference is by studying the two different modes (A and B) in which the following picture can be perceived.

Fig. 7



Modes of perception :

A. An one-sided view { either a cup (by focusing only on dark)
or two faces (by focusing on white)

B. A two-sided view { both cup and faces (by recognizing both sides of the picture)

The one-sided view is characteristic of today's world view, the other for the world view now primarily being formulated in physics and psychology. The emergence of a fundamental principle (like this one) has the potential of leading to dramatic new gains and insights.

The following examples serve to start to open up an awareness of these new potentials, and reveal the limitedness of the one-sided vision. Let us start by explaining the difference of these two thinking modes in the composition of a simple picture.

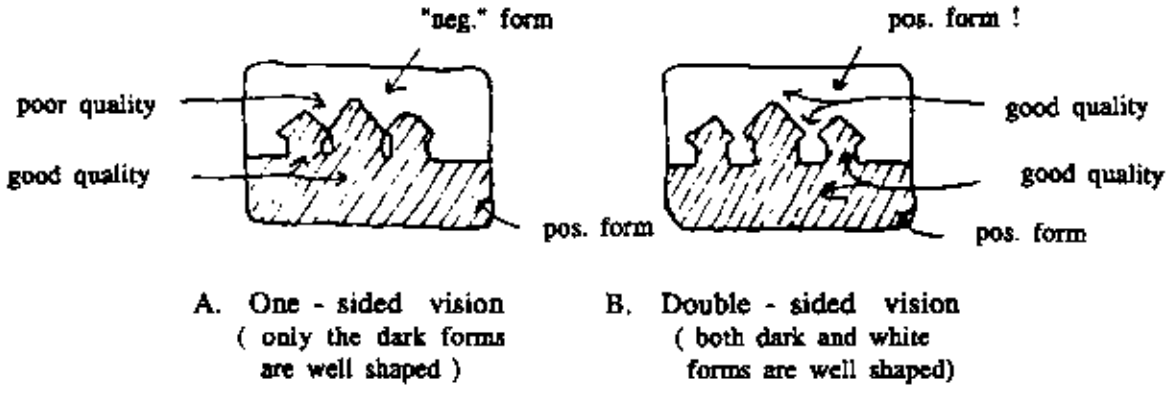


Fig. 8

An useful approach is to look at these diagrams first only as pictures to study "positive" and "negative" forms. Then we can proceed to look at them as specific designs such as roof-gables or a design for a street-front where both the forms of the houses and the spaces between them are well formed, and harmonized as a whole. This shows us how this thinking is applicable at various levels of visual design.

The next picture provides another example; this one from architecture, where in case A, only the windows have good proportions but in case B, both the windows and the panels have good proportions. The standardized production of building elements, where the context and the wholeness in which they eventually will stand are not considered, makes impossible to reach the high quality of scheme B.

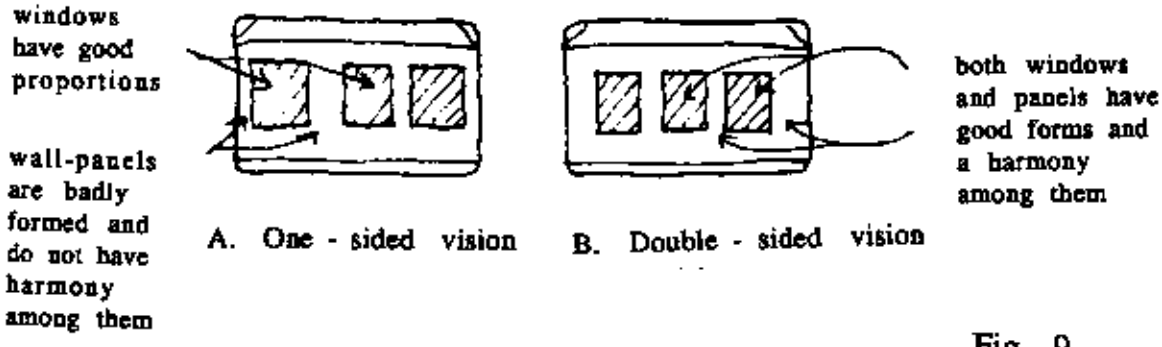


Fig. 9

These have been simple and direct examples of the two different modes of thinking. Most design classes pay some attention to this; a serious deterioration in this faculty in modern design has, however, occurred, fueled, in part, by the use of modular elements (windows, panels, etc.) that are developed singularly without a view of the context, or the wholeness, in which they are going to find themselves.

In city-planning the same flaw also appears. The designing of the city plan has been parceled out to two separate disciplines: i.e., the design of the "dark spaces" (houses, architecture) and the designing of the "white spaces" (open space-, garden architecture). Usually the forms of the white spaces are bad because they are given little thought at the stage of the main conception, because the architects usually first arrange space and then the "accidental" remaining spaces are left for the garden architect to do his cosmetics.

That these two sides of a plan cannot be separated, rests in the not well understood fact, that by drawing a

single line on a paper, one is always forming two forms, as in the following picture.

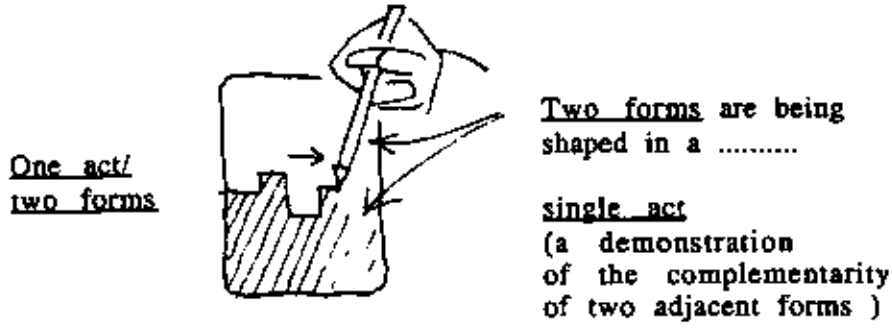
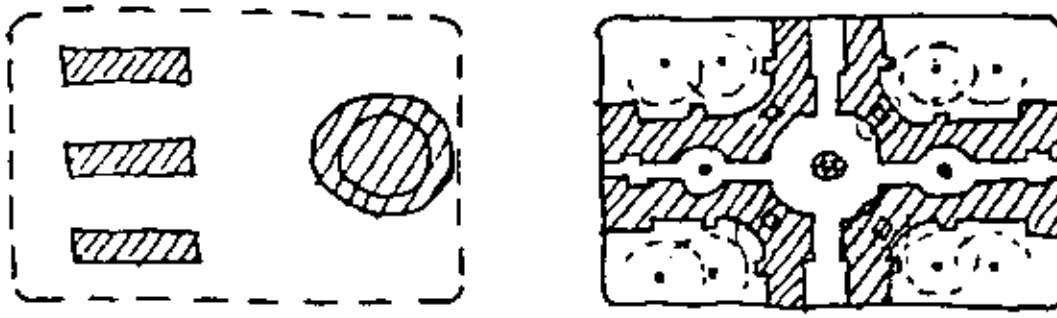


Fig. 10

Some might argue that the one-sided view is capable of post negative-form/positive-form analysis. Yes, that is true, but this requires a dialogue that is difficult within the current segregation of the design-field into separate professions. In addition, the basic design principles seldom get much discussion, the conception tends rather to be the lining up of prefabricated elements or concepts.

Let us now look at examples from city planning to clarify the difference between the one- and two-sided approaches. The first example (A) is typical for the modern situation, the other is an example of the balanced approach (B) where both the masses and open spaces have good shapes and clear volumes.



A. Only the spaces of the houses have good volumes, the open spaces little sense of a volume

B. Both the houses and the open spaces have good volumes

Fig. 11

A good method for checking the quality of the open spaces (i.e. their volume, connections, rhythms, etc.) is to get a negative of the plan in a copy shop or from a photographer. By going back and forth between the positive and the negative, one can improve each of the aspects (mass and space) with full regard for the other. Many cultures have different abilities to deal with this duality; the old southern Europeans were good at this.[9] The good climate and the sense for the social aspect, i.e. the common spaces of the city, has e.g. made Italians design squares as interior spaces.

Ashihara (1983) explains this in the following way:

> ...we can envision a space such as the Italian square surrounded by architecture as being equivalent to 'figure' in the Gestalt sense...
>
> A beautiful example of the Renaissance-style square is the Piazza Ducale...To stand in this square is to experience vividly the quality of spatial unity that Zucker believes is typical of the Italian Renaissance piazza...
>
> The composition of this square is a clear example of the Italian talent for transforming external space into roomlike interior space. (pp. 55-57).

The following positive and negative picture, from Ashihara's book, of an area in Rome, Italy, shows how beautiful and balanced the forms and the systems of both the masses, and the open spaces are.

Rome : massive areas dark

Rome : open areas dark

Fig. 12

This sensitivity and care for both aspects of things can also be studied within the field of environmental action-- i.e. in the balance of give and take, which is always there. Let us first look at this in the diagrammatically most simple way.

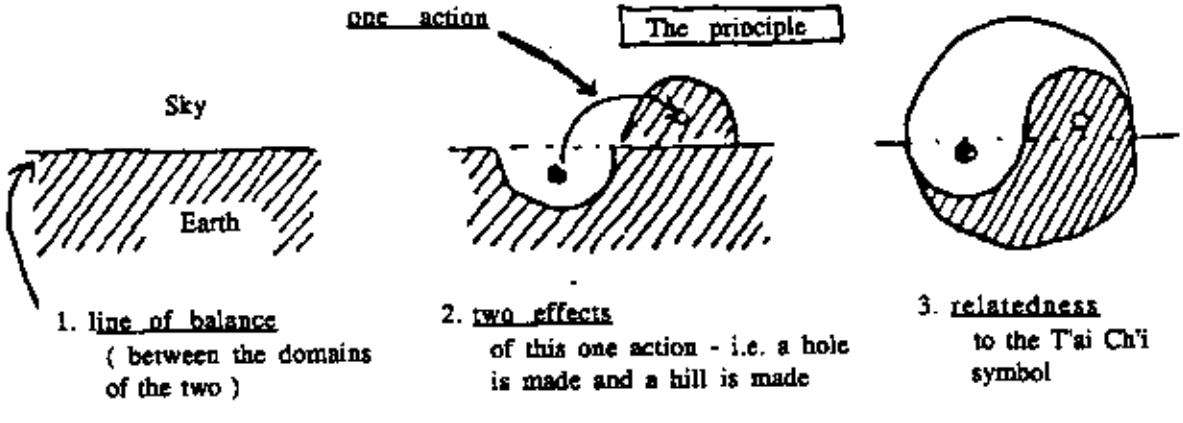


Fig. 13

Picture 2 shows us how this principle; "one action has two effects" occurs in the moving of material. The third

picture--the T'ai Ch'i symbol--is added in order to illustrate the relationship of the "two-effects" principle to the way this Oriental symbol is designed.

The economy and beauty of the application of this balance-principle, can be observed in earlier "ecological" modes of building (see the pictures).

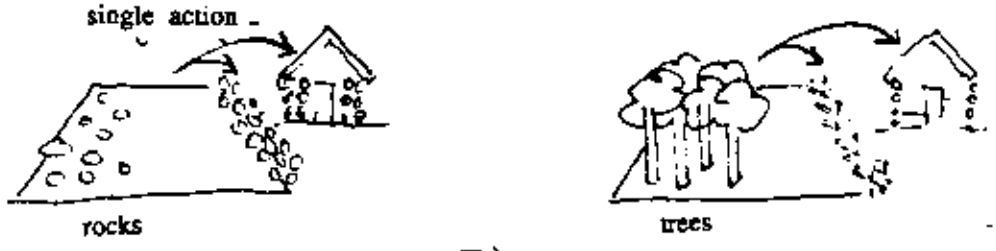


Fig. 14

The double economy of this is sometimes understood by today's planners:

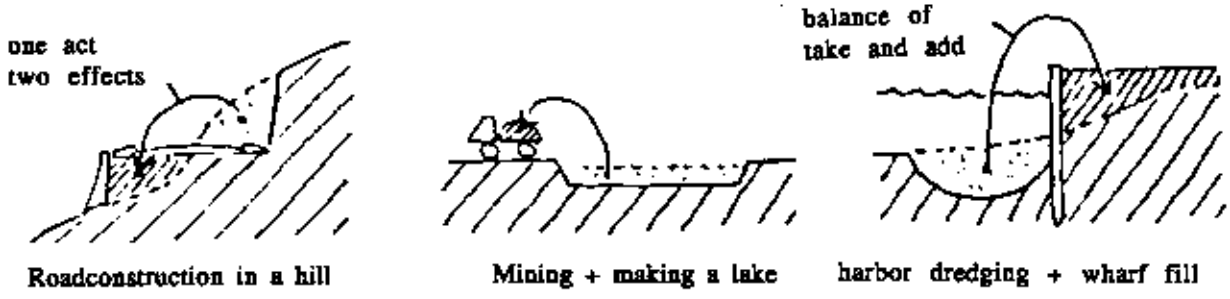
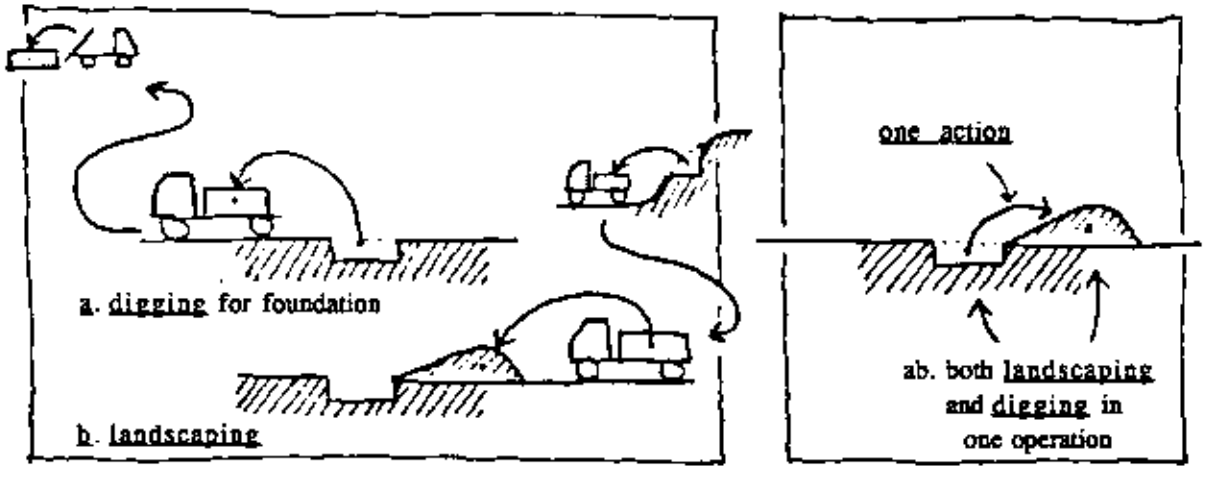


Fig. 15

This balance of output and input is being postulated as a central principle in a "new" approach to design called environmental or ecological planning, which is presented in the following picture (B) in a contrast to today's

expansionistic approach (A).



A. " The expansionistic way " of not understanding to combine the two operatins (producing wastes and damaging landscape)

B. " The environmental way " of combining two operations (also the right soil for the site)

Fig. 16

If this strikes the reader as isolated but practical and interesting examples, later chapters show that these are profound principles.

3. Attempts at understanding the concept of complementarity, plus examples that illustrate some of its power

The concept of complementarity has primarily been worked on within three disciplines; quantum physics, color theory (complementary colors) and in Oriental philosophy (the interacting of yin and yang). In all these disciplines many things remain unclear about the nature of complementarity.

In 1927 the Danish physicist Niels Bohr introduced the concept of complementarity in quantum physics. In a "Biographical Sketch" in the book: Niels Bohr, Collected Works, Volume 1 (1977), Bohr's grand idea is explained in the following way:

> The introduction of the notion of complementarity finally solved the problem of the consistent incorporation of the quantum into the conceptual framework of physics. From the epistemological point of view, the discovery of the new type of logical relationship that complementarity represents, is a major advance, which radically changes our whole view of the role and meaning of science. (p. XL)

Prigogine and Stengers (1984) explain Bohr's theory in the following way:

> Bohr always emphasized the novelty of positive choice introduced through measurement. Bohr expressed this idea through the principle of complementarity, which may be considered as an extension of Heisenberg's uncertainty relations....They all deal with the same reality, but it is impossible to reduce them to one single description. Bohr used to say that the significance of quantum mechanics always made him dizzy, and we indeed feel dizzy when we are torn from the comfortable routine of common sense. (p. 225)

Bohr expressed the importance of the T'ai Ch'i concept when he became knighted; he included that symbol in his insignia together with the phrase "Contraria sunt complementa" (Latin: Contrasts are complementarities).

The practicability of complementary colors (red, green, etc.) i.e.; the ability of such color pairs to mutually enhance each other, is widely known and used in art and design. The formulator of the theory connected to this was J. Itten; a teacher in the first years of the Bauhaus, after the First World War. His books on the subject include

Elements of Color (1970), The Art of Color (1973) and Design and Form (1975). The influence of Oriental ideas on his theories is well known.

In her book; A Primer of Visual Literacy (1974) D.A. Dondis gives some insight into the "mystery" of phenomena linked to viewing a complementary color.

> ...the eye is seeing the opposite or contrasting here, not just in the afterimage, but at the same time it is viewing a color. The process is called "simultaneous contrast" and its psychological significance extends beyond just its importance to color theory. (p. 52)

In his book; Creativity and Taoism (1983), C. Chang for instance quotes Chuang Tzu (on p. 36): "Not to determine 'this' and 'that' is the very essence of Tao..." A good example on how such wordpairs can not exist on their own merit but only because of the existence of the other element can be studied in the word-pair hill/valley (see the picture):

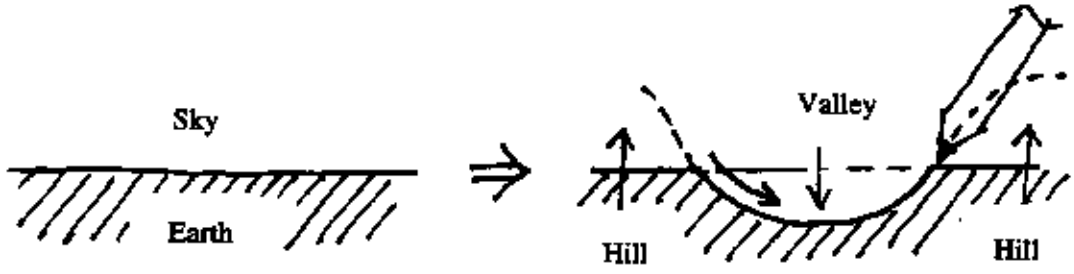
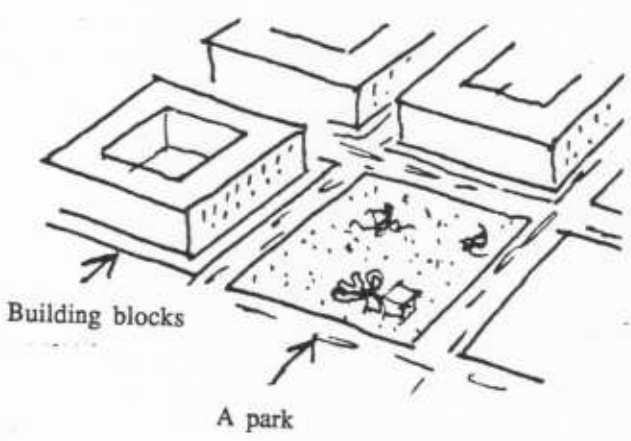


Fig. 17

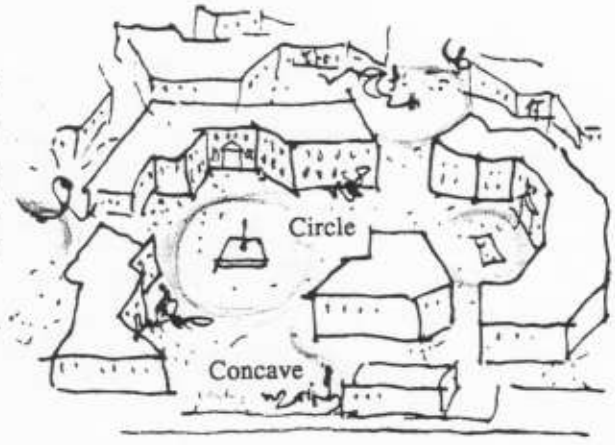
The nature of the phenomenon of the mutual interdependency--and thus also the mutual enhancement that occurs with such complementary pairs--can be understood from this picture, i.e.; the valley cannot be made deeper unless the hills also become higher. A further example on this

mutual interdependency is that an urban area cannot have a strong expression of urbanity unless it has a reference point in a rural area or park that is located close to it.

The clearest demonstration that I am able to bring on the power and the importance of letting complementary pairs work together in design, is the following picture pair that contrast today's dissectionized approach (A) and the complementary-mutual enhancement approach (B):



A. Planning of buildings and open spaces in a seperated way



B. Planning of buildings and open spaces together (they enhance and complem. each other)

Fig. 18

Today's dissectionizing of the design-field into building-architecture and garden-architecture makes approach B very difficult. My claim is that the profoundness of the complementary working together of the two is hard to realize, unless we again combine house- and garden-architecture in one profession. On the planning level this would be a combination of city- and landscape-planning into one profession.

II. THEORY BUILDING

CHAPTER 3: The main concept and the four interrelated principles it consists of

1. The form-equivalents of the principles and how they appear in ecology and in the T'ai Ch'i symbol

Before we start to study the form-equivalents of the principles, let us have a look at how J. Koh formulates the ecological nature of the three principles (summarizing the work of many scientists) in his dissertation: An Ecological Theory of Architecture (1978).

> The three fundamental forming principles of Nature can be derived from Physics and Biology as: Unity, Dynamic Balance, and Complementarity. All are signified as an interrelated whole in the Neo-Confucian symbol T'ai Ch'i (The Great Ultimate) evolution from "Mu" (Nothingness) by the "Yin-Yang" principle, and all are apparent in biological evolution and ecosystem development.
>
> Unity is the first principle of ecology, a manifestation of the principle of Conservation and the First Law of Thermodynamics; Dynamic balance is the main principle of evolutionary biology, a manifestation of "Principle of Stability" and the "Second Law of Thermodynamics" of the open system. Complementarity, the third principle in ecology, relates organic and inorganic systems, life and death, subject and object. It relates to Relativity theory and the Uncertainty principles in modern physics. These three concepts happen to correspond neatly to the traditonal ordering principles in design; unity, balance and contrast. (p. 89)

In his dissertation, Koh does not deal directly with the geometric or form properties of these conceptual principles (i.e. I. the Circle, II. a Convex/Concave line and III.

Complementary form-features) although he uses them as illustrations in the respective chapter headings.

In his later work he has increased the "tactile" quality of his theory with more examples and by the defining of forming or aesthetic principles. In his paper: "Ecological Aesthetics" (1984) he, for instance, gives examples on how the three principles can be used to define principles of aesthetics. Some of these definitions verge on being geometric or topologic in character. Examples:

> On Unity: "--Figure characteristics are affected by their relationship to ground." (p. 30)
>
> On Dynamic Balance: "-'Counterpoint' and local symmetry in overall asymmetry (or vice versa), enhances richness of aesthetic experience." (p. 30)
>
> On Complementarity: "--The integration of positive/negative form, solids with voids, indoor with outdoor, building with garden; enhances the aesthetic quality of the built environment and art work." (p. 31)

Let us now start to define the geometric qualities of the three principles of the T'ai Ch'i symbol--and how they interrelate--with the help of quotations. First from An Illustrated Encyclopedia of Mysticism (1976).

> Yin, Yang...these are not, like the Pythagorean opposites, dualistic principles of evil and good. Both are complementary parts of a single cosmic harmony, and merge and change and interact with one another. (p. 212)

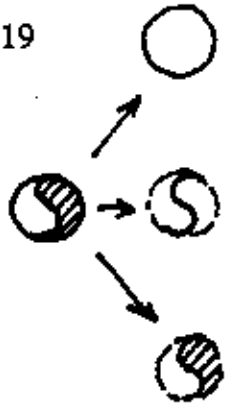
And from the German book dtv--Lexikon politischer Symbole (1970), (in my translation):

> Yang-Yin-Symbol, is a religious and world view symbol that is widely distributed in East-Asia (Chinese: T'ai Ch'i). It is formed from a circle that is divided into two parts by an S-shaped line. All elements of the

> cosmos were ascribed to the two groups. The diagram of the T'ai Ch'i (the first reason) shows accordingly one united wholeness, the circle, that encircles the separated elements of all the reality of the cosmos. In other words: the T'ai-Ch'i-Diagram stands for the harmonic coexistence and the interrelating of opposites under one universal law. (p. 266)

Following these quotations one can define the form-equivalents of the three principles with the help of the T'ai Ch'i diagram:

Fig. 19



I. The Circle stands for wholeness and unity.

II. The Convex/Concave dynamic line--and how the two halves interpenetrate each other--stands for how the halves "change and interact with each other." (That this occurs both ways stands for balance, and this connected with "change" gives; "a dynamic balance").

III. Complementary features. Such pairs are polarities within a given phenomenon. In landscape hills/valleys, in coastlines concavities/convexities, in color theory complementary colors. The origin of complementary pairs in a neutral state can best be seen in the fact that when mixed together they create one diffused wholeness (like e.g. when black/white or red/green colors are mixed they produce gray).

The fourth principle, a principle I have added to the form theory, sometimes appears in the T'ai Ch'i symbol. I term this principle (because it is easily understandable in that way): "Core of the opposite (...area)," whereas the term: "Cores of the complementarities," would be a more correct term.

The meaning of this fourth principle is more complicated than of the others, but in the West it is best known through

the study of Animus/Anima in Jungian psychology. The nature of this principle A Dictionary of Symbols (1982) explains in the following way:

> Animus/Anima...Symbolic figures...of the masculine forces in a woman, and feminine qualities in a man...The feminine principle in nature, the core of the archetype, cannot be experienced directly, but only manifests itself in women etc. Men get cut off from this experience, if they lose contact with the part inside themselves which responds and corresponds to the feminine. (pp. 14 to 20)

The principle: "Cores of the opposite" is widely used in Japanese garden design; an amazing example of this are the gravel gardens with their rocks; the ripples in the gravel symbolize water and the rocks islands in the water. The following picture is taken from the chapter "Territories of Architectural Space" in The Aesthetic Townscape (1983) by Y. Ashihara (p. 28):

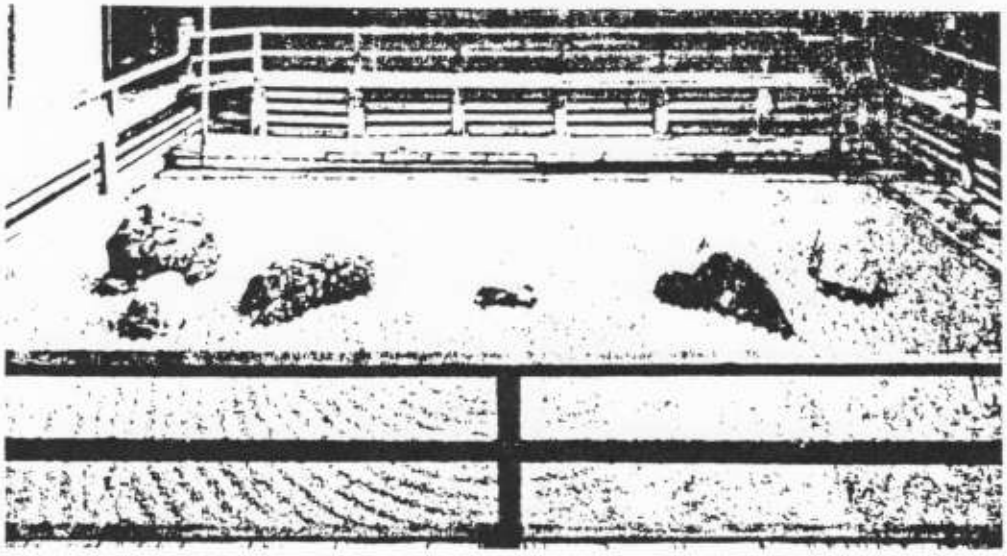


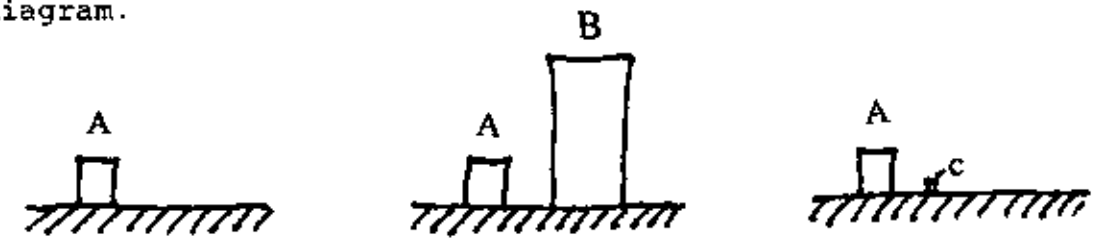
Fig. 20

The geometric or rather topological characteristics that corespond to the fourth principle can be broadly defined with the help of the T'ai Ch'i diagram:

Fig. 21

IV. Core of the opposite corresponds to the need for a point(s) of reference within an area, especially if the area is large. Each of the two complementary halves need a core to respond to, and this also maintains the symmetry (the balance) of the scheme.

The need for a reference point to assess a quality or a size, can be easily understood with the help of the following diagram.



The answere to the question: " Is A a large or a small house " ?
depends on the existeance and choice of a referance point (B or C)

Fig. 22

The core-principle appears widely in architecture and planning. The two following examples are from these fields.

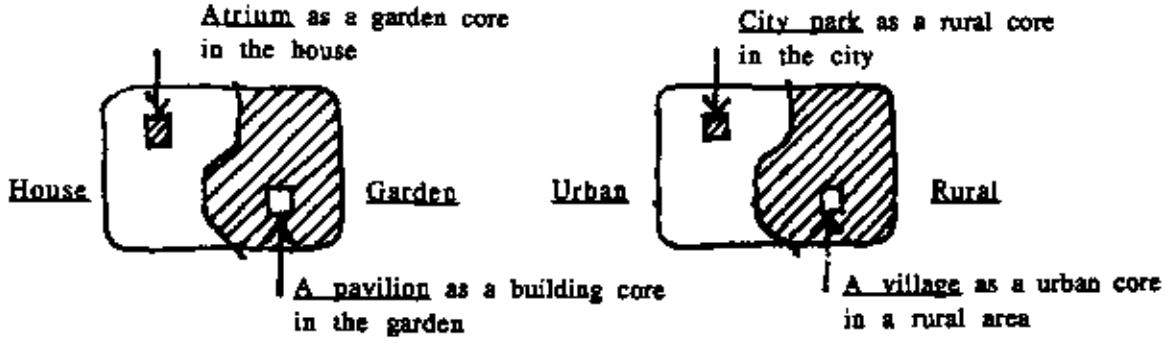


Fig. 23

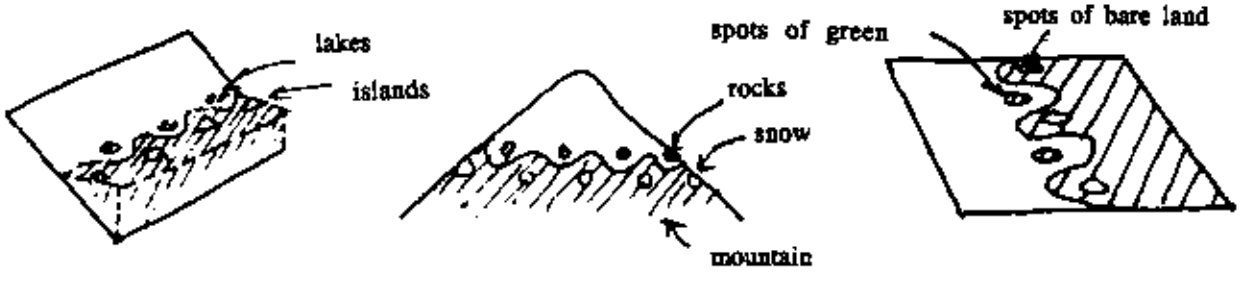
The Oriental atrium--courtyard--principle found its way into Western architecture around the turn of the century, but the scheme most often remains uncompleted (and thus lacking balance) by leaving out the building core in the garden. The

theoretical content of this section forms the basis for the formulation of the propositions about the geometric and functional qualities of the four principles, that will be formulated in Chapter 4.[1]

2. How the form-principles appear at interfaces in nature and occasionally in cities

Although probably of not much help in the precise definition of the form-principles, a look at how the principles appear at interfaces in nature, as well as at interfaces in cities that have evolved naturally, may be illustrative. These two examples clarify the links of the principles to basic natural phenomena.

Let us now look at a diagram with three examples. The first two examples explain these patterns as a result of an occurrence where a randomly shaped topographical terrain is "flooded" by another material (water or snow). The third example (vegetation) is independent from topography in its displaying of these patterns--but here other random features are at play. (See the diagram).



1. Land / water 2. Land / snow 3. Land / veget. cover

Fig. 24

These diagrams are of course generalizations, because sometimes the edge between the two areas is unclear and sometimes the "cores" appear as irregular forms. Although these are only three examples they, however, may indicate that the four topological rules that appear in these three types of interfaces are possibly universally valid generalization of basic patterns in nature.[2]

In this century, science's quest for discovering the laws of nature, has taken place almost entirely within the functional realm. A study of form has not been considered to be a serious science. My "discovery" of these patterns as interface-patterns in nature, is related to the recent discovery of the so-called fractal geometric patterns of nature. The fractals are topological patters that appear in many versions and on many scales. An important book on how fractals appear in nature is The Fractal Geometry of Nature (1977) by B. Mandelbrot.[3]

Man has learned through long experience how wise an adjustment of his life and actions to the laws of nature can be. This adjustment of man has, however, primarily occurred within the realm of physical and functional laws. What I am proposing with my theory is, that it is also advisable to do this same within the realm of form-giving, i.e. to use general patterns of nature in design. This can for instance be done with the help of the form-patterns of nature discussed here.

In this chapter I have tried to uncover some of the

logic behind these patterns. This analysis of underlying principles is necessary (as in all scientific inquiry) if the principles are to be used skillfully in a synthesis. Also a skill has to be developed, to be able to spot these principles, these patterns, both in nature itself, as well as within other phenomena. This is a skill based on a morphological sensitivity, as opposed to the numerical sensitivity of the mathematic skills, that are governing in today's sciences.

To demonstrate how this morphological analysis can happen within planning, in the reminder of the section, we will review a series of schematic examples.[4] First a picture that provides an overview.

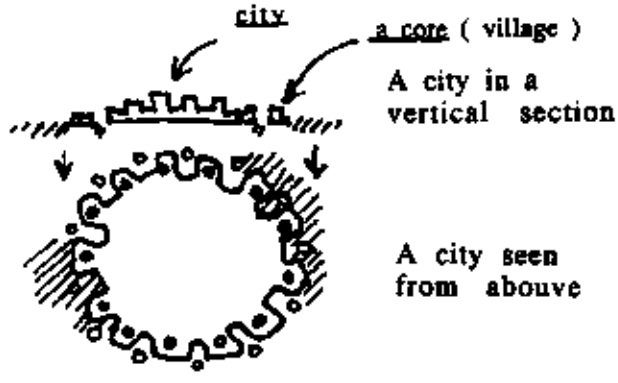
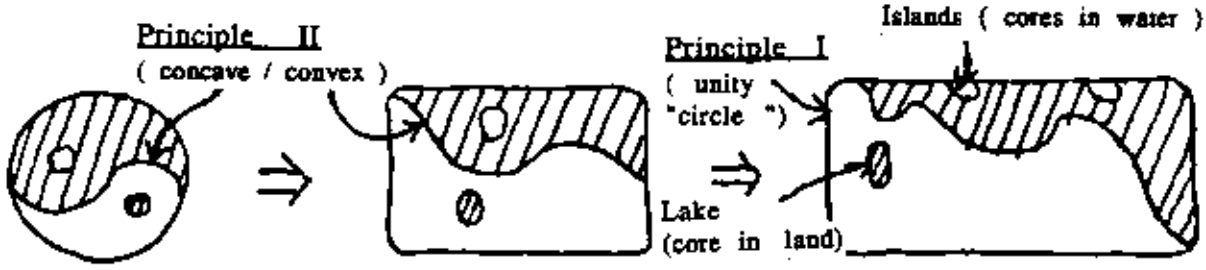


Fig. 25

Let us now look at how the patterns look at a section of an interface, i.e. the meeting of a land-area and an ocean-area.



1. General principle
(The T' ai Ch'i)
2. Intermediate step
3. A coastal area

Fig. 26

The first principle (unity, circle), can be seen in the fact that a land-area and the adjacent ocean-area, form a natural geographic unity. The second principle (concavity/convexity) can be seen in the alternating concavities and convexities of the coastline.

See now the three main levels of scale in convexity/concavity in the following picture.

1. Macro- level
2. Medium-level
3. Micro-level

Fig. 27 Concavity / Convexity on three levels of scale (on the same coastline)

The convex/concave principle can also be seen in vertical sections going through cities, i.e. in the alternation between hills (convexities) and valleys (concavities). (See picture.)

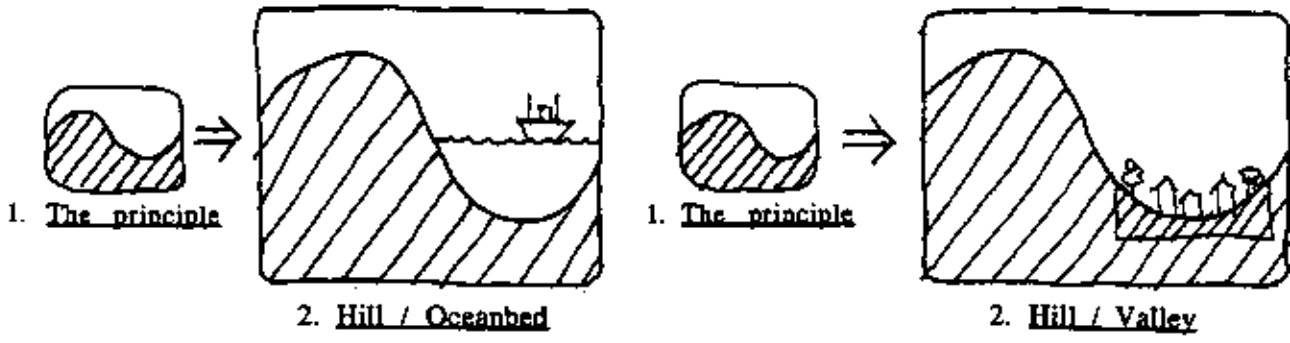


Fig. 28 Concavity / Convexity in a vertical section

The complementarity-principle exists in the horizontal plan, in the complementarity between land/water and urban/wilderness--and in a vertical section in the complementarity between hills and valleys and between earth and sky.

The fourth principle (cores) exist at the land/water interface in the form of lakes and islands (as shown before), and at the urban/wilderness interface as parks in the city and village cores in the wilderness. All the patterns appear both at high and low levels of scale.

CHAPTER 4: Foundations needed for the study of form in design and planning, and propositions on the form-principles

I. New methods in mathematics for studying function and general qualities of form

Before we start to study the specific form characteristics of the form-principles, a look at how the study of form stands in general is useful. Also a study of what methods--useable for the study of form (primarily within mathematics)--have been developing in recent times, is beneficial.

In the preface to Aspects of Form (1968) L.L. Whyte, in generalizing on developments in the study of forms in the 1951 to 1968 period, indicates:

> The main changes on the scientific side can be summarized very simply: greatly increased interest in spatial form, many new and important facts, and only relatively minor advances in theory. (p. X)

Historically the study of form was of prime importance in science in the nineteenth century; known there as morphology (Gr: form-logy), and this method was the key to classification and understanding e.g. in the realms of botany and zoology.

That these methods could not be stringently formulated at this time in mathematics, led to this important tool being pushed to the side. Only in one discipline; geomorphology,

has this method achieved a high scientific status. Geomorpholgy is the science of how to read geologic information and history out of the shapes of the various geological and landscape patterns and formations. Additionally, a syntax has developed--the grammar and alphabet of this language--so that the geomorphologist can actually "read" the shapes (the signals) of the landscape as we read the signals of a printed page.

Natural scientists have never lost interest in form and the most skillful of them can decipher the correspondence of a physical-form and life-form in both directions. An ornithologist, for instance, can explain the form of a bird (long legs, long beak etc.) from the kind of envionment the bird comes from, and ecologists can outline what kind of life-form can thrive in a given physical environment. Although the example on birds'-forms seem to derive from function (i.e. feeding), the forms actually derive from form in nature, i.e. here depth of the mud and water.

This lesson from the natural sciences, and the beauty and deep truthfulness of the match between the physical forms of an environment and the life-forms existing in this environment, has motivated many designers to strive for this match, this fit between designs and their physical environment. Many beautiful examples of this match can also be found in indigenious design.

The landscape architect who has most clearly formulated this type of design-theory in the United States is Ian

McHarg, author of Design with Nature (1969). In this work, he outlines how to study (decipher) the forms of nature (form in the widest sense) to be able to recognize what types of human activities can fit to each given area. McHarg seems to be frustrated with the lack of understanding of this type of method (i.e. the study of form) among planners of human settlements. He says in Design with Nature (1969):

> Form is not the preoccupation of dilettantes but a central and indissoluble concern for all life. (p. 173)

The problem with the ideology of McHarg and the Naturalists is that they want the forms of human endeavors to adapt to the forms that happen to be in the given location, whereas I opt for the design-philosophy that the forms of settlements should primarily be adaptive to human needs, and that landscape forms (e.g. shapes of coastlines) should be changed in cases where that can serve human purposes. The following pictures contrast these two approaches.

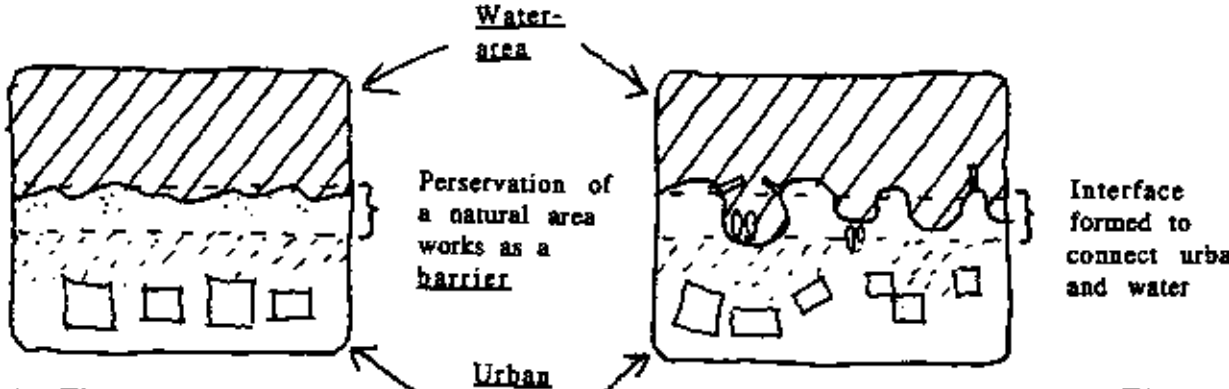


Fig. 29

One can agree with the Naturalists, however, that much can be learned from patterns in the spatial organization in

Nature. An important criterion is to let the forms of settlements be expressive of their functions, i.e. forms should be used as tools to structure the emotional not less than the functional criteria. An example on this is how a circular form can be used to enhance unity and community--terms that include both functional and emotional (togeatherness) values.

Let us now--to prepare ourselves for the study of the form-qualities of the four principles--have a brief look at new methods within mathematics that have been developing in this century. These methods help us discern the most basic qualities of shapes, forms and form-relations.

Mathematics up to this century primarily dealt with quantities and sizes, and the particulars of the shape-characteristics of form (geometry, etc.). The history of this development is complicated and involves many new disciplines. Let us now look at how Encyclopedia Britannica (1965) explains topology:

> This branch of mathematics is so fundamental in nature that its influence is apparent in practically every other branch. Because of its foundation in general-set theory, topology is not limited in its applications to problems of a quantitative character and it may therefore contribute to research in fields, such as the social sciences, that have not been considered susceptible to mathematical treatment. (Vol. 22, p. 298)

On the special characteristics of topology the encyclopedia further states:

> ...topology became known as a type of geometry--formerly called analysis situs, or 'position analysis'--in which the shape and size of configurations are unimportant...

> It gradually became recognized that any collection of things, be it a set of numbers, algebraic entities, functions or mathematical objects, can constitute a topological space in some sense or another.

Topology, founded in the general set-theory, defines the use of the terms Conjunction, Intersection and Complement. The definition of Complement in a mathematical way is of importance for my study. Of most relevance for this inquiry is, however, the term Universal Set, which corresponds to the words Wholeness and Unity in my terminology. The Universal Set is explained in the following way in the book Principles of Mathematics (1955):

> ...there is given in advance a large set, called the "universal set U," to which X is supposed to belong. This set may vary from situation to situation...but is fixed for the duration of a particular discussion. (p. 9)

The term "complement" is derived from the universal set, and is defined in the following way:

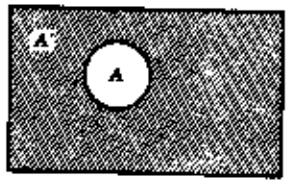


Figure 1.6

"Definition: Let a set A be a subset of a universal set U. Then the complement of A, written A', is the set of those elements of U which are not elements of A. (See Fig 1.6, where A' is shaded)." (p. 20).

Fig. 30

This mathematical formulation of wholeness (an U-set) and a division of it into a pair of sets (a subset and a complementary set), is of use for clarifying the logic within these generalizations.

Only certain wholenesses (certain U-sets) are, however,

of interest for my design theory. These are "natural wholenesses," wholenesses that constitute a "complementary pairs" as found in nature. Examples of such pairs are land/water, hill/valley, concavity/convexity.

An example of a "natural wholeness" that can be defined stringently is "white light." If one takes a color (a subset) out of the full spectrum of a white light then the remainder of the spectrum constitutes a complementary set. This is the scientific foundation of complementary colors as defined in the theory of color.

2. Propositions on the basic qualities of the form-principles, and a theoretical supporting of them

The following discussion of each of the four principles will be started by a definition of the form-properties of the given principle in the form of a proposition, whose value then will be advocated for theoretically.

Proposition on principle I: The Circle. The term "Circle" is used here to refer to the type of spatial organization of elements that comes close to an overall circular arrangement (i.e. we are not using the term in its meaning "circumference" or an exact geometric shape).

According to this, an area can have much or little of circular quality (a square, e.g., has more of this quality than a long rectangle). The most basic quality of a perfect circle is that it is the most dense, the most unified,

spatial organization of elements in a two-dimensional space. In a three-dimensional space the sphere is the most dense type of arrangement.

That this is the spatial organizaiton that gives the most unity of elements makes it applicable as a form-maxim for realizing the social objectives: unity, wholeness, community. (Illustrated here:)

Fig. 31 A. Low unity of elements B. High unity of elements

This quality of a circle, i.e. the dense arrangement of elements is by far its most important quality in planning. Other features that a circle often has i.e. an accentuated rim, a distinctive center and circular or radial structures (e.g. in the form of roads, piers, break-waters) can help enhance the centering quality of a circle. These secondary features will be dealt with in section 3 of this chapter.

Proposition on principle II: The Dynamic (convex/concave) line.

This form-principle contains two basic qualities: 1. It increases the length of the dividing line between two areas (opposite to a straight line that per definition is the shortest distance between two points). A prerequisite, from the view of this theory, is that the dividing line between areas (the "interface" or "interphase") should be filled with

activities that connect the areas. Given this prerequisite, a longer interface (a longer "glue surface") creates a stronger bonding than a short one.

In some few cases an interface needs to have a separating function (Example: a prison wall). In still other cases it is meant to separate (filter) some functions but allow others to connect (we may want to connect a water-area and an urban-area but we may, however, want to prevent the unrestricted access of small children to the shore).

If we wish that an interface connects areas, the interface has to have several qualities besides the concave/convex one. Most importantly, it needs to have width, i.e. enough space to accommodate facilities that can serve to connect the two areas in question. Also it should not be too steep, rocky, etc.[5]

These connecting facilities which I call exchangers, are similar to interchangers in transportation networks. How they function, and how some of them in coastal areas have a natural connection to convexities (vistas, places to fish from), and concavities (places for boats etc.) will be discussed in section 3 of this chapter, and in the case-studies.

Let us now continue to study the pure form-qualities of a convex, concave line. The following picture pair explains that a curved line gives us the possibility of a longer "glue" surface than a straight line.

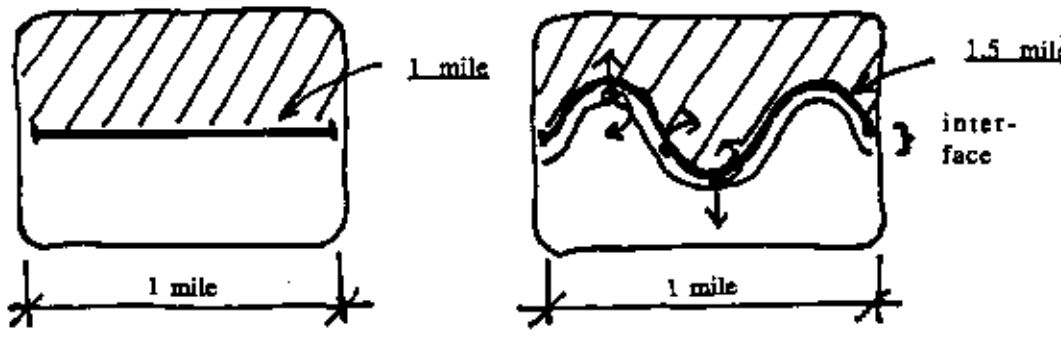


Fig. 32 A. Little interrelating B. Much interrelating

The second form-quality aspect is the alternating concaveness/convexness of a Dynamic line. This quality (again opposed to a straight line) allows the two areas to reach into each other, and this type of spatial organization can help in the realization of the social objective of more interaction and interrelation. (See the picture for an illustration.)

Fig. 33 A. A straight interface does not allow a deap reach

B. A convex / concave interface allowes a deap reach

Proposition on principle III: Complementary form-features

In this section, the meaning of the term "Complementary form-features" will be explained by examples (see next

picture). In the language of our dissectionized world view, such feature-pairs are called contrasts or opposites. This illustrates clearly that we do not understand that such pairs (if brought close to each other--which the principles I, II and IV contribute to) can complement and mutually enhance each other (see p. 30).

Complementary form-features can be both very elemental, like: squares/rounds, vertical/horizontal, black/white and they can also be a composite of form-characteristics that for instance (in a more symbolic way) express an urban vs. a rural character.[6]

The secondary characteristics, typical for a given type of an urban area or a water-area, can vary as greatly as smells, sounds, colors, textures, structures. The proposition of this principle is that a high intensity of such features is a tool applicable for achieving the social objective of more interaction and more interrelation between such areas (see the picture for an illustration).

Fig. 34 A. The character of the areas does not interrelate them

B. The character of the areas interrelates them

Why this use of polarities enhances interrelation is not fully understood in physical science (like e.g. the pull between magnets) nor in the psychology of perception (i.e. in

the mutual enhancing that occurs between complementary colors), nor in the psychology of animals (i.e. in the pull between males and females). Nevertheless, the existence of these interrelating phenomena has been dealt with in many studies. Through analogy to the principles of these fields, we can provide a theoretical support for my proposition on the applicability of complementary features in planning. The support of this proposition, however, depends on the outcome of case-studies more than is the case with the other principles, which have a stronger theoretical support.

Proposition on principle IV: Core of the opposite

The quality of this principle can be seen as a combination of the second quality of principle II that states that the interrelation area becomes wider because of the concavities and convexities. The cores have the same effect. Because of this, the area that the complementary effect of principle III reaches becomes larger (see the picture for an illustration).

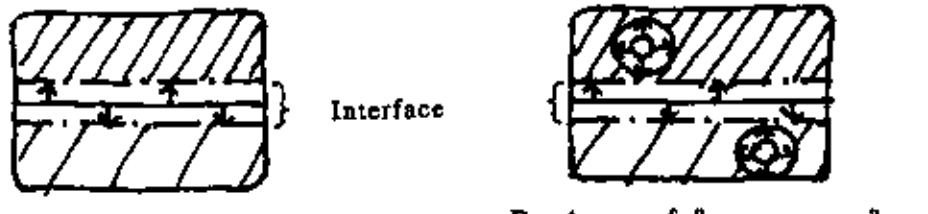


Fig. 35 A. Only areas close to the interface are aware of the other realm

B. Areas of " awareness " are enlarged by the cores

That the core of the opposite is in the "heart" of an area, and thus surrounded by this area contributes especially to the utility and expressive power of a core. Because cores

are such distinct topological phenomena, a core has a different and more intense complementary value than is the case in the complementarity of two adjacent areas. An example is that a city park has a more focused value as a point of reference than a landscape area adjacent to the city has.

3. Secondary features that contribute to the richness of the four principles

Principle I: The Circle

The quality of the Circle that is, by far, of most fundamental importance, is that it is by definition the densest arrangement of elements in a plan (see p. 59). The other geographical or structural features listed in the following scheme can help enhance the circular and centering quality once the shape of the two adjacent areas in question comes close to the proportion or the shape of a circle. These features listed in the table below are my compilation of basic geometric structures comprising the quality of "richness" in a circular form.

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape		
2. The accentuation of the rim		
3. The area has a focus		
4. Circumf. structures that enhance the sense of a circle		
5. Steepness that links land-area to water		
6. Radial structures lead to the center		

(10 represents the ideal)

Fig. 36

Final evaluation of presence		

Feature 1: "Approximation to a circular shape," was discussed in the previous section.

Feature 2: "The accentuation of the rim" can happen on land, for example, with a line of houses or a wall as the next picture illustrates. On the water-half of the circle this accentuation can for instance be intensified by lighthouses or a watchtower (also see the picture).

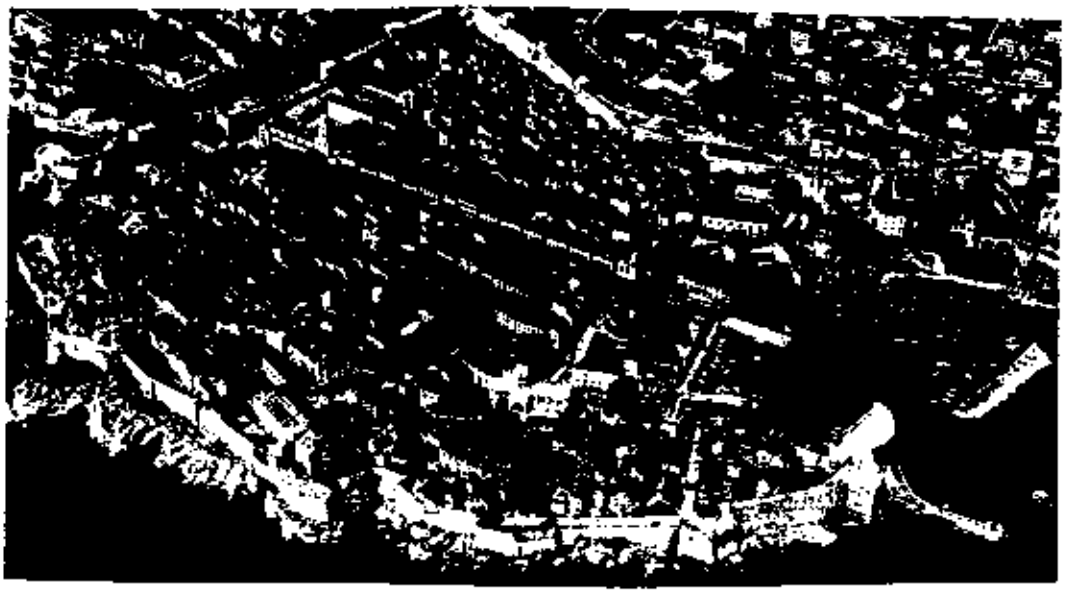


Fig. 37

Dubrovnik i
Yugoslavia

Feature 3: "The area has a focus" often comes to be through the designing of an open area at or near the center of the circle (see the picture below).

Fig. 38

Piazza de Campo
(Siena, Italy)

Feature 4: "Circumferential structures that enhance the sense of a circle." On land these can be topographical contour lines, land-use patterns and streets that go in half-circles around a central area (see the picture).

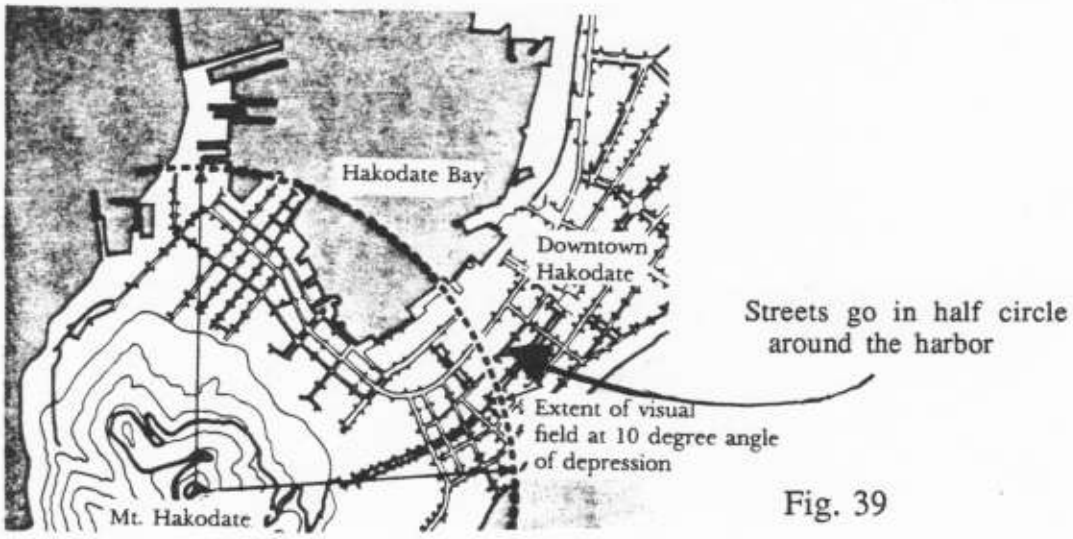


Fig. 39

Feature 5: "Steepness that links land-area to water." The picture above provides a good example. Ashihara explains this picture, this feature, in the following way:[8]

Mt. Hakodate...provides an unobstructed and unsurpassed

view of Hakodate Bay...an angle of depression at 10 degrees from the summit of the mountain includes an arc that embraces the city of Hakodate proper as well as the oceanfront and port. (p. 100)

F. Violich explains the same feature in an article on Yugoslavian harbor-towns (see the drawing below).[9]

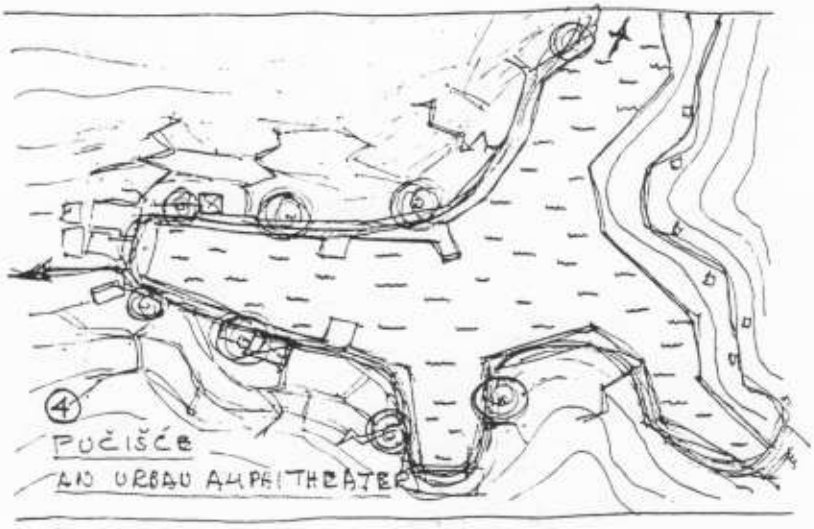


Fig. 40

He explains the setting in the following way:

The houses on the steep slopes appear to be seats on steep balconies. (p. 6)

Feature 6: "Radial structures lead to the center," can in a water-area be piers that point towards the center and on land, radial streets that lead to the center.[7] (See the picture below).

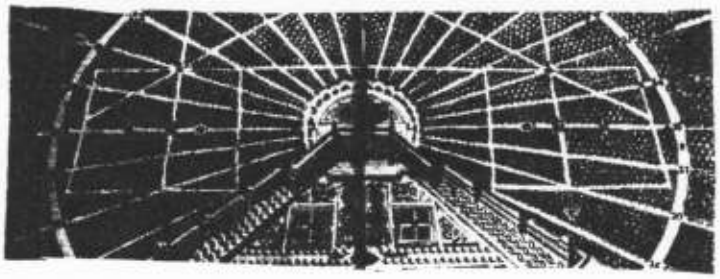


Fig. 41

Karlsruhe
W- Germany

The secondary features of the circle that have been explained here will be evaluated in the six cases from Reykjavik in the case-study section. The check-list that appeared at the beginning of this section will be used to provide an organized overview.

Principle II: The Concave/convex line

Besides the fundamental mathematical qualities of a concave/convex line, i.e. the increased length of an interface and the widening of the interaction area (see p. 62), concavities/convexities have aesthetic functions.

Ashihara explains them with the following pictures and a text:

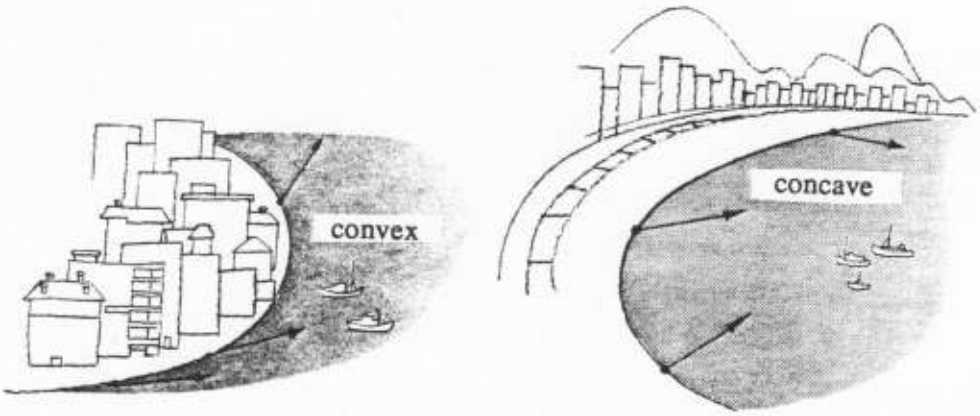


Fig. 42

Ashihara explains[10]:

> In a convex landscape the land juts out into a body of water and there is no boundary circumscribing the water... (p. 103)
>
> A concave curve calls attention to the body of water, forming a relationship between water and land... (p. 103)

Functional features are often directly linked to convexities (lighthouses, vistas) and to concavities (natural harbors, calm and sheltered outdoor-areas on beaches).

Some such features are what I call exchangers.[11] An example of this are fishmarkets: the cycle of the fishing boats exchanging fish for money from household cycles. These exchangers are especially effective in creating a functional interrelationship between water and an urban area. Other examples of exchangers are: a landing place for sightseeing boats and facilities for swimmers, and surfers and an aquarium.

A long interface (it has also to have a width) provides more space for land/water interactive features. The following picture shows how far this principle can be taken.

Fig. 43

Cocoa Isles in Florida

Principle III: Complementary features

Ashihara explains the complementarity of an urban- and a water-area in the following way:[12]

> A city on the edge of a body of water is particularly striking because of the juxtaposition of the natural and the man-made. (p. 100)

Many basic types of coastal areas exist. Examples:

fishing harbor/fish producing area, recreational area/recreational harbor, industrial area/industrial harbor, residential area/boat harbor for residents.

In some cases the land- and water-functions do not match--e.g. a residential area at an industrial harbor. This matching relationship, or lack thereof, will be studied under question III in the case-studies.

Principle IV: Core of the opposite

Cores of the opposite can be islands and rocks in water and lakes and pools in land. The case-studies will study whether their presence helps relate the land- and water-areas. (Question IV).

In most cases, rocks and islands help in the definition of a water-area. In the case-studies, this comes in as a factor in the study of a circle quality. Even so, I will bring a passage from Ashihara's book here because it refers also to the aesthetic value of rocks in water:[13]

> Most seascapes extend unbroken from the water's edge to the horizon...A scene punctuated by islands or other features, however, is far more striking. One famous example in Japan is near the Ise Shrine in Iutamigaura bay, where the so-called 'Wedded Rocks' stand just off the coast...This pair of rocks brings the scene into focus and gives a sense of cohesiveness to the seascape. (p. 103)

A core (an island or a lake) needs a communication-channel between them and their "parent-area." Examples of such channels between land and an island is a causeway, a bridge and a ferry connection. Rivers and brooks are the

communicative channels between a lake and a sea. The carrying capacity of these channels is influenced by many factors, such as depth of water (i.e. what types of boats) level of pollution (can fish live there?) and water speed (can rowing boats go against the current?).

The existence and non-existence of these cores will be discussed in the case-studies together with the question whether their existence and functioning helps, or has helped, the interrelation of the land- and water-areas that are the subject of the case-studies.

4. Environmental features that contribute to the biological richness of a coastal zone

The most basic environmental features of a coastal zone are its topography and topology. Topography has to do with heights and depressions of the terrain. A water body's edge forms a concave line along the depressed portion of a coastal terrain, and a convex line at protruding portions.

Topology explains how elements of the landscape; small bodies of land and water form cores within the realm of the other area. Examples: islands and rocks in water and lakes and pools in land. These basic characteristics of a landscape (in interaction with forces of nature such as rainfall, tides and waves) form the foundation for what type of natural activities thrive within each given location.

Let us now start to define this further with the help of

natural scientists. In his essay on the geology of coasts A. Gardarsson explains how the topography of the terrain influences other features of a coast line:[14]

> Steepness and shape. Steepness has much effect on how wide the shore is. Where steep rocks go into the ocean the coast is only a narrow strip but in bottoms of fjords the intertidal zone can be very wide... Where the terrain is uneven, seawater remains in depressions at the ebb tide. The environment in such beach-pools is similar to that of subtidal zones because there no danger of drying out (of organisms) exists. The ecology of such pools is though somewhat special, especially in the upper zones of a beach. The shape of the coast also has many other influences on life conditions. Rockridges and skerries can for instance function as natural breakwaters. (p. 65)

In a section on ocean processes in Earth (1975) F. Press and R. Siever explain how currents and waves have a role in shaping the secondary features of a coastline:

> The minimal wave energy extended along the inner shores of bays makes the water quieter there, making secure places for mooring ships. It is in bays that beaches form on an irregular shoreline of headlands and indentations. (p. 243)

The following diagram accompanies the text to explain better what it describes:

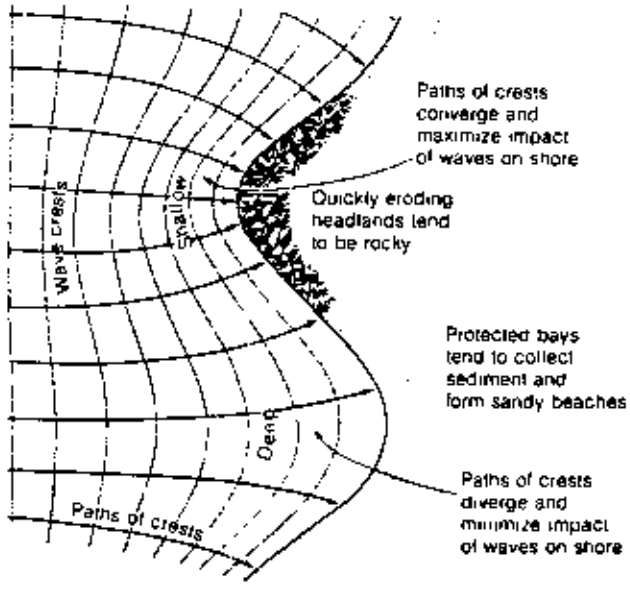


Fig. 44

Wave refraction around a headland and bay

In his essay, Gardarsson explains the relation of the intensity of surf and intensity of life on a seashore, in the following way:

> Surf has much influence on the structure of the coast, and also has an effect on the life there... Much surf limits the life-conditions for many species both because it puts sand and gravel into motion, washes organisms away or injures them or even prevents biological remains from accumulating there. (p. 65)

Watersheds form around concavities, depressions, in a landscape, and the rainwater flows from there towards a coastline. Most water gets accumulated at the lowest point of a depression. Therefore most of the rainwater flows into the ocean at the bottom of concavities on a coast. This means a lower salt content of the ocean-water as one comes closer to the bottom of concavities (also less exchange of water there because of fewer currents and waves).

Once Gardarsson has explained the features determining the existence and diversity of organisms, he procedes to show what types of organism are associated with each of these features. This he explains in the chapter "Division of biota into zones." On this he says for instance:

> One of the most outstanding characteristics of the ecology of a coast, is the distribution of species according to certain patterns. This appears especially clearly in the case of the algae, where zones of algae-species can be observed as one goes up or down the coast. (p. 70)

This Gardarsson explains with the following diagram.

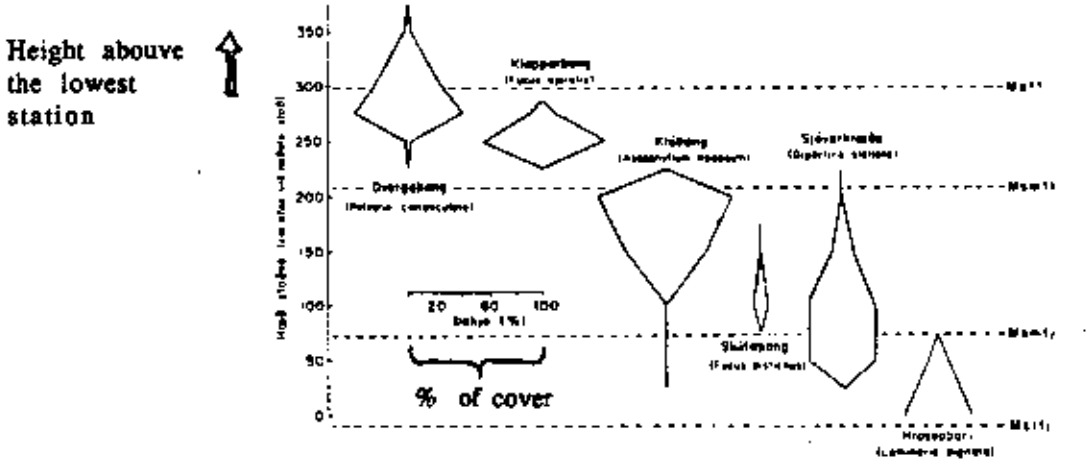


Fig. 45

One aspect of the case-studies is to study whether richness in human activities at the coast (and thus richness in the interrelation of land and water) is linked to the richness of natural activities in the same area. This is discussed in the introduction to each of the research questions.

III. THE CASE STUDIES

Introduction

1. Why the first settler selected the site of Reykjavik

The site of Reykjavik was settled in 874 by the Norwegian Ingolfur Arnarson who then became the first permanent settler in Iceland. Ingolfur was a farmer and fisherman; therefore the natural features of the location were of a great importance to him. Most of these were directly or indirectly linked to the basic topographical and topological characteristics of the area. No other location at the southern part of the large bay Faxafloi has more diversity of topography (islands, lakes, etc.) than the location that Ingolfur chose for his settlement. (See the following map).

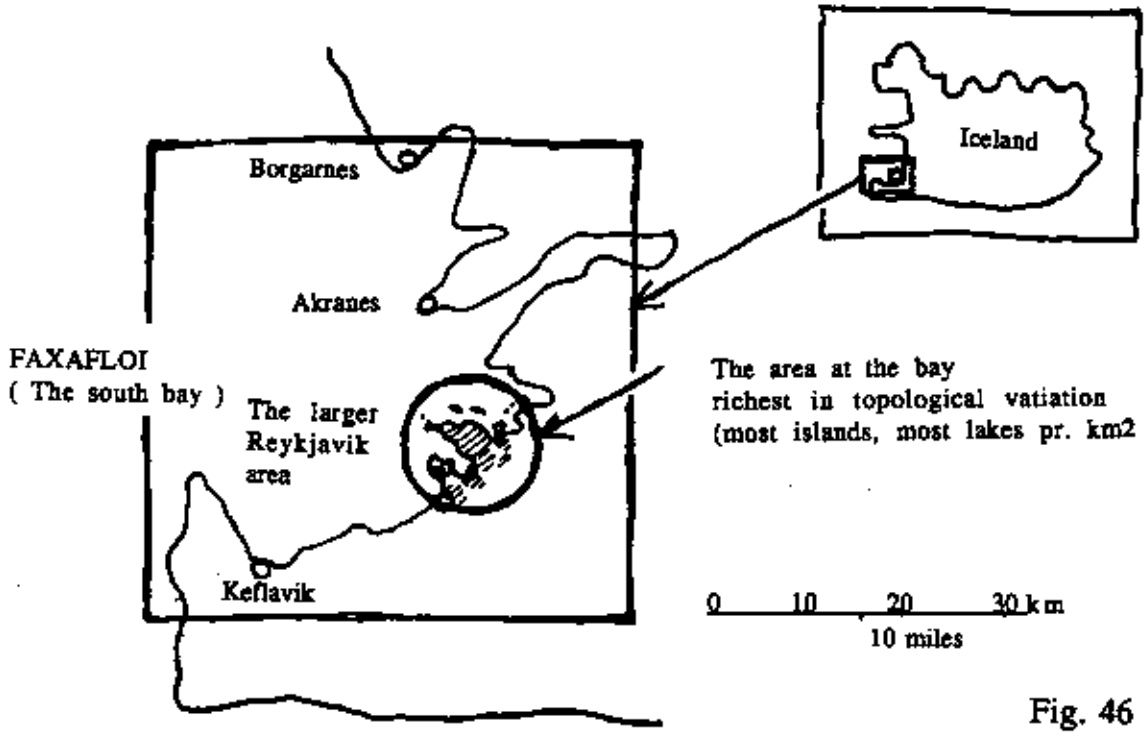


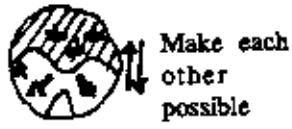
Fig. 46

For the livelihood of Ingolfur and his followers these four basic "topological" qualities of this location, were of fundamental importance as can be seen from the following description:

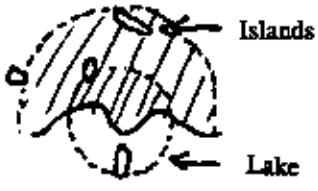
Fig. 47

I. A good coastal farming area and good fishing grounds in the adjacent water area, i.e., the two form a tight ("circular") land/water unit.

II. A good convex/concave quality of the coastline; the concavity creating a naturally sheltered harbor.



III. Because of Ingolfur's dual role as farmer and a fisherman the water and land were two complementary resources essential for his livelihood and that of his people.



IV. The water-core in land: The Lake provided fresh water as well as freshwater fish and water fowl for his farm. The land-cores in water (the islands), provided the harvest of their specific ecosystems, and were also particularly useful as "enclosures",

because at this time material for effective fencing of lifestock in fields was hard to produce.

The topographical names of the islands clearly underline the importance of the enclosure effect. Akur-ey ("Fields-island") denotes that cornfields there were protected from the livestock on land. Eng-ey ("Meadows-island") shows that there the grass-fields, likewise, could be kept free from the cows, the sheep and the horses. The island Geldinga-nes ("Gelding-peninsula") was a little further from the farm. (It held castrated livestock, which did not need to be close to the farm.) Its name suggests, conversely, the utility of islands as means to fence in the animals. A similar example from the U.S. is South Padre Island in Texas, which was once a very large cattle ranch, using water as a fence to keep in the cattle.

2. How Reykjavik developed into an industrial and fishing village with an ever increasing importance of its coastal zone

The descendants of Ingolfur remained powerful for a few generations after the intial settlement but then they disappeared from the annals and the sagas. When Reykjavik appeared again in documents after the Middle Ages it was not a seat of power any more, the church there was poor, and the area of the farm on the Reykjavik-peninsula (Seltjarnarnes)

had been divided into several small farms.

Reykjavik remained a farm for almost nine centuries, but then the expansion of the world economy that accompanied the Age of the Enlightenment led to the establishment of an industrial village in Iceland. The Reykjavik farm was selected as the site, and the village with its wool mill and other buildings was constructed in the summer of 1752.

In 1866, Reykjavik's era as a primarily fishing-oriented town started with the arrival of the fishing smack Fanny. This led to an increased construction of piers going out over the flat sandy beach. However, these piers were too short to allow the smacks and cargo ships to embark there; the ships had to be anchored on the open harbor and be loaded and unloaded by small cargo-boats (see fig. 48). It was not until 1915 that the harbor was enclosed by breakwaters, and major piers for ocean-going ships were constructed.

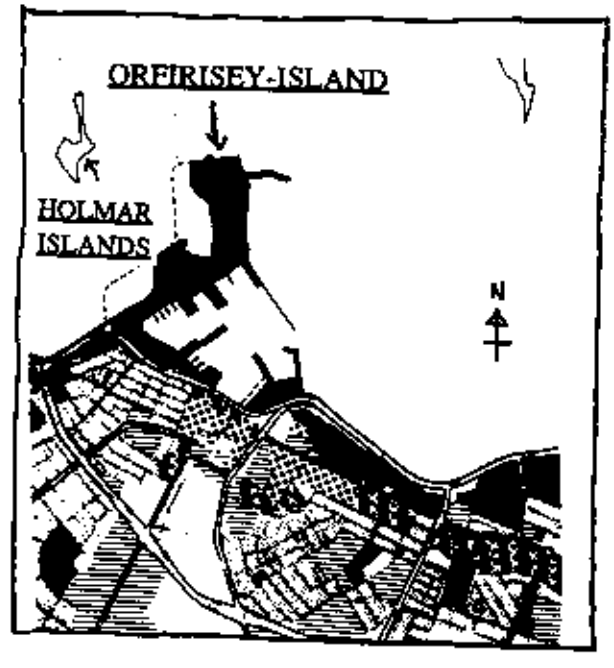
Fig. 48 Reykjavik in 1876

3. The role and the development of the topological qualities (islands, etc.) in Reykjavik

The history of the islands north of Reykjavik is most interesting because of their active role in the development of the Reykjavik region. Farms were established on most of the islands in the early ages of settlement and some of them - Holmur, Therney, Engey and Videy - had their own churches.[1]

Northwest of the Reykjavik farm was a cluster of islands (See Fig. 49). These islands were connected to the "mainland" by narrow causeways that surfaced during the ebb tide. This topology provided the ideal setting for a commercial harbor, because transport to the mainland was easy and at the same time the islands were easy to defend from attacks, both from land and sea. This was an important criterion in the ages of lawlessness.[2]

YEAR 1715 - Fig. 49



YEAR 1982 - Fig. 50

The Holmar-islands (at the top of Fig. 49) are today mere reefs, due to erosion and subsidence (1 to 1 1/2 meters in 1100 years).

When the village of Reykjavik was established in 1752 the commercial houses of the Holmar village were located in the Orfirisey (Effersey), an island north of Reykjavik, but later these commercial activities moved to Reykjavik. The Orfirisey-island is now the North corner of the Reykjavik Harbor. (See Fig. 50.)

The island that has the most significant history is Videy island (in the upper right corner in Fig. 51). There a monastery was established in 1226, and it soon became the wealthiest monastery in the country, owning at one time about 116 farms. From the conversion from catholicism to protestantism, which was enforced by the Danish king around 1550, a period of decline began in Videy.[3] In 1754 a new period of prosperity started when Skuli Magnusson, the Treasurer of Iceland, made it his residence. He built a house and church that still stand on the island.[4] In 1909 the Milljona-company built the first harbor in Reykjavik for seagoing ships, in the eastern part of Videy and also a small fishing village.[5] At the same time a dairy farm (50-80 cows) flourished, selling its products to the village and to Reykjavik.[6] With the construction of the Reykjavik Harbor at the time of World War I, Videy's harbor was no longer competitive because companies preferred to be located on the mainland. Since about 1950 nobody has lived in any of the

beautiful islands north of Reykjavik.

Changes to the landscape features of the North Coast of Reykjavik have contributed to a decline in the links between Reykjavik and the water and landscape areas in its vicinity. (The details of these developments, are described in the six case-studies which follow).

4. The location and a brief description of the six case-study areas

Historically, Reykjavik's North Coast is the coastal area that has the strongest connection of work- and leisure-activities to the ocean in the city. To the south of the Reykjavik-peninsula, the ocean is too shallow for ships.

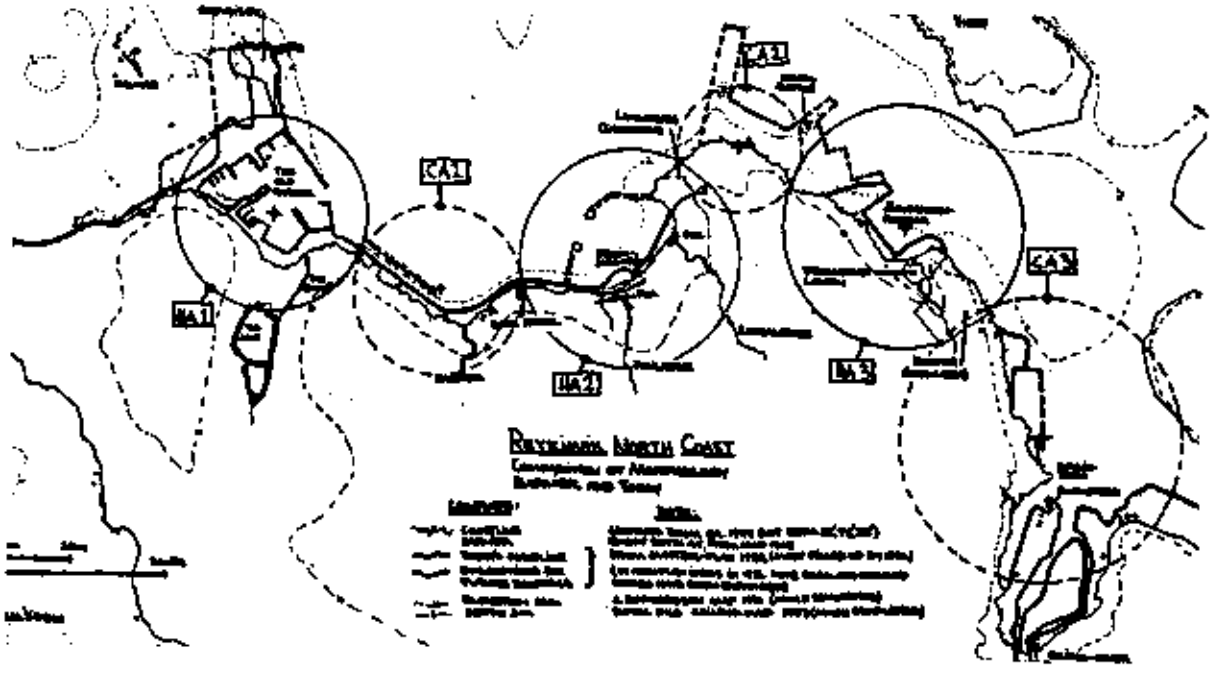


Fig. 50

Today, the North Coast is divided into three harbor-areas (HA) and three coastal-areas (CA). For the purpose of this analysis, I have labelled them HA1, HA2, HA3 and CA1, CA2, and CA3 (See fig. 51). HA1 is the Old Harbor (which has been mentioned already), HA2, the Kirkjasandur-harbor where fish-processing plants have been located most of the century (the master-plan of 1948 reinforced this use, and modern plants were built there according to this plan[7]); HA3 is the new cargo harbor called Sundahofn which started operation in 1968.

CA1 is the Skulagata-Hofdi area where today hardly any directly coast-related activities are located. At the eastern end of this area is the Hofdi-house where the Reagan-Gorbachev summit took place in 1986.

CA2 is the Skarfaklettur-area which has some of the original features of the coastline but is today spoilt by a scrap metal-company and a small oil-storage station. Harbor-landfills are planned here, but some of this area could be saved for the use of outdoor activities.

CA3 is the Gelgjutangi-area. At the north part of it is a landfill where the cargo-ships of the union of co-op's in Iceland (SIS) land. Gelgjutangi, in the middle, has two small wharfs for boat repairs, not an unpleasant human-scale sea-related activity. The southernmost part is a steep coast protected by Iceland's nature-preservation law because it provides a rare exposure of geological information.

This area also has an inlet that separates the coastline

from the landfill that now occupies the portion of the bay in front of it. The inlet was created deliberately to protect the geologic formations that are visible on the coastline here. The landfill was created between 1967 and 1982 with material excavated in the course of the development of the Breidholt area. The mudflats covered by the fill were the estuary of the Ellidaar salmon river. It had been a significant feeding area for birds. In the past few years the first sport-boating harbor in Reykjavik was constructed at the end of this landfill closest to the coast.

The study of these six areas of the North-Coast of Reykjavik describes their characteristics in terms of the four morphological principles dealt with in the hypothesis and registers their decline or improvement in this century. Finally a documentation of the natural processes and human-activities related to these areas is presented in a matrix ,with notes on their decline or improvement. (A fold-out sheet at the end of the text.)

The text on each of the four topological principles (Ch. 6 to 9) supports two aspects of the argument suggested by the hypothesis, i.e.:

(A) some of the natural processes and human-activities are dependent on the morphological features contained in the four principles, and (B) these activities (in the islands, on the coast etc.) contribute to the positive functional interrelationship between the urban area of Reykjavik and the water-area north of the city.

CHAPTER 5: The formulation of the research questions, and the methods and data applied for answering these questions

Introduction

In deciding what type of case-study to do, two alternatives were studied. The first idea was to do the same type of study of towns in many countries to be sure there would not be culture-specific characteristics. Here, for instance, one can point out that, in the USA, the interrelating of an urban area and its surrounding areas (land or water) is, in general, not seen as important. The goal, however, was not to study differences in cultural preferences, but rather through a detailed study of the form-principles, to determine in what way and to what extent the application of principles would enchance the interrelating of urban- and natural-areas, if the goal of interrelating is desired. Therefore a comparative study between cultures was not required.

While I was inquiring into what kind of data would be necessary for this case-study, I discovered that in the general town-planning literature little material exists on land/water interfaces in towns, as has already been described.

As Reykjavik has been, to a considerable extent, a fishing and seagoing town, much data exists on the interrelation of the urban area and the water area, and the "interface": the shoreline between them. A native of Reykjavik, I have worked

in Reykjavik's Planning Office for more than six years, and written the book Reykjavik: The Urban Fronteer in Iceland (1986), therefore I feel that I am in a good position to do this study in Reykjavik.

Originally I also proposed to do this study for the interface where the Reykjavik urban area and the surrounding wilderness areas meet. After having studied the material available on this subject I realized that such a study would be much harder to do than the one on the coastal area because the urban/wilderness interface has been constantly moving away from the center of the town, making a comparison of form-qualities over time much harder.

In contrast the location of the coastline has changed very little. The form-qualities, however, have changed greatly (e.g. a loss in the convex/concave quality of the coastline). This offers the possibility of studying how these changes in form have affected functions and activities in this same location.

The study of a second interface would not have provided knowledge much different from that gained in the study of the coastal interface. To focus only on the urban/water interface would make the case-study of this interface much more comprehensive.

- - -

Four research questions will be investigated through the case-studies. Each of these questions reflects one of the four form-principles. Because the methods required to respond to each of these questions are somewhat different, the type of data required to evaluate each question varies somewhat as well.

Question I: Does the degree of circular closure present in the meeting of two adjacent urban and water areas affect their interrelationship?

In each case we need to define the circle; its measure of roundness and secondly its measure of relationship (activity).

The response to this question starts by showing the areas of all six cases on a map. A circle is drawn around each of the six areas to check whether landscape features define a circular quality. On land our clues are primarily contour lines, on sea it is primarily islands (outside the area), and breakwaters (especially if they are semi-circular in shape) that can help define the circle. The data on this are thus morphological data taken from various types of maps. My description of the extent to which the circular form is present, in each of the six cases, is then registered in one of the summary tables.

Then we come to the second aspect: is the functional interrelationship between the two adjacent water and land

halves in the six areas, strong or not so strong measured by the amount of interrelating human and ecological activity that occurs between them?

For each of the four questions being examined in these case-studies, I concentrate on the functional aspect of the interrelation between land and water because this is an area where one can relatively easily collect dependable data. In the question on the value of the Circle principle, the data on the interrelation of the land- and water-halves are data on "harbor" activities. For the period before the Reykjavik Harbor was established (in 1915) these data come mostly from historical essays, but since 1915 the data come from the Reykjavik Harbor, land-use plans, etc.

Most of the activities that enhance the interrelation between land and water take place on the "line" of the interface between land and water.[8] This area (called interface), and activities linked to it, is dealt with specifically under Question II, which deals with the value of the presence of concavities and convexities in this interface.

Question II: Does the amount of richness in the concave/convex quality of the coastline affect the amount of ecological and human activity?

The science of ecology has established knowledge of the close relationship between biological complexity and the

complexity the physical aspects of nature. These aspects include variations in landscape forms, variation in moisture, acidness, etc. This means that a richness in physical form exists in nature, a situation is provided for a richness in ecological activities. These principles are touched on by Ian McHarg in Design with Nature (1969). He states, for example:

> . . . within any generalized area there will be ideal examples. . . . In these locations, presumably, there are some special successes that are visible and comprehensible. The ecosystem the organisms and their organs are not only fit, but are most fitting (p. 170).

Ecology thus teaches us (as explained in Chapter 4, Section 4) that richness in the convex/concave form-quality of a coastline leads to a richness in terms of diversity in life-forms on this same coastline. (For a definition of the morphological richness in concave/convex form, see in Ch. 4, sec. 3).

Icelanders have a long tradition of being connected in their livelihood to natural resources. To keep and feed lifestock for food production in a country of long winters is costly and therefore people tried to make as much use as possible of the scarce food-resources found in nature. Almost every species of plants, birds and fish have thus been utilized, which means that a diversity of man's activities in a given area is closely linked to the diversity of the natural resources of a given area. I will support this point about the link between these two types of diversity (richnesses) with various types of data.

Even though the utility aspect of this diversity is becoming less important in contemporary times, other more leisure-related activities have come in their place. A diverse landscape and wildlife is a stimulus for recreational activities (such as birdwatching, fishing from the coast, etc.).[9] In exploring this aspect of human activities on a coastline, the question is whether recreational activities exist there that can be linked directly to certain types of concavities and convexities, i.e. activities which are independent of the ecology as concerns their linkage to these areas.

The data on the convexities/concavities come from an air-photo and from old and new maps. The data on the activities linked to these form-features come from biological reports and from new and old reports and books on the human activities on the North Coast of Reykjavik.[10]

Question III: Does increased leisure- and work-related activities occur between an urban and a water-area in cases where the functions on the water- and urban-areas are a complementary pair?

In answering this question one must start by determining what the characteristics and uses of the land and water areas are. The second problem is to determine whether the characteristics and uses of these two adjacent areas match (fishing harbor to a fishing-area, residential area to a recreational water-area, etc.).

The analysis begins by documenting the degree to which each of the six urban areas has a seagoing function, with a footnote on how well this gets expressed in the area's morphological form. The data come from land use maps, maps with street patterns and from photos. Then, the character of the water areas is documented--types of ships and harbor activities, together with notes on other close-by environmental characteristics. Data: photos, drawings, maps.

Once one has established what these morphological features are, the question asked for each of the six cases is whether a matching relationship exists between each pair of adjacent urban- and water-areas. "Matching relationship" means for instance that a harbor with fishing boats has a fishing-town character, and that a residential area on a coast is matched with facilities on the shore for the residents: restaurants, a boating-harbor, etc.

The next step is to make a judgement on whether the adjacent land- and water-areas enhance each other as they are today. The data here are the numbers of functional relations between the two areas. These data are the same as in Questions I and II, but here the focus is whether these activities link adjacent areas. An example on where this is not the case, is HA2 where fish processed here needs to be transported from HA1.

If the cases with a matching relationship have a strong functional interrelation, and conversely if cases with little or no matching interrelationship have little or no functional

interrelation, then my hypothesis is positively supported.

Question IV: Can the presence of land-cores in water (islands, etc.) and/or water-cores in land (lakes, etc.) have a positive influence on the interrelation of land- and water-areas?

This question actually includes two separate parts, and they will be dealt with as such, but because they deal with two appearances of the same principle the methodology in answering them is similar. Therefore they are stated in one question; in a question on the value of the cores-principle as it comes to interrelate two areas.

The methodology here is similar to that of Question II which deals with the value of concavity/convexity as concerns the interrelation between a land-area and a water-area. I will, however, briefly restate the main components of the methodology, now referring to the cores, where I earlier referred to the concavities/convexities.

The first part of the question contains the following steps:

Step 1: Ecology has established that each type of core (island, lake, pool...) has a matching type of ecology (island-ecology, etc.). Each of these ecologies contributes some specific types of species or processes to the diversity of natural life in the area.

Step 2: Icelanders have a tradition of making use of all the natural diversity in the area where they live.

Step 3: A conclusion from this is that the greater the

natural diversity (based on form diversity) in a land/water interface (concavities, convexities and the cores of the various types), the greater the diversity and volumes (richness) of the human activities in the area (See the Glossary for a definition of richness).

The second part of the question studies whether certain types of human activities can be linked directly to the form- or topological characteristics of the cores. This has to be answered specificly for each type of core - and this will be done in Chapter 9. The question that will be answered first in that chapter is to what extent did the various types of cores exist in the areas' natural state - and after that; to which extent have they been lost (or new ones formed)?

More than in all the other questions, accurate and detailed morphological data are needed here, preferably from air photos because most maps omit small scale cores (rocks in water, pools...). Because only a small amount of urbanization occurred in the eastern part of the Reykjavik-peninsula before the building-boom that began around 1950, an air photo taken earlier than that would be sufficient, and fortunately the earliest air photo with sufficient resolution and clarity is from about 1948. I borrowed this 1:10,000 scale photo from the City Planning Office of Reykjavik and plotted the coastline and the water- and land-cores as well as possible.

Water-cores in land are hard to see so I may have missed some important ones. Land-cores in water are more easily

recognizable because of the white sea-foam. Also a sailing map from 1959 was of help.

For the western part of the North Coast a rather accurate map exists, which was measured and drawn by the Danish army in 1902 and published in 1903 at a scale of 1 : 5000. At that time, no closed harbor or landfills to speak of had been made in Reykjavik, so this map shows the costal area close to its natural state.

The data mentioned here, I put together on a large highly detailed map, at a scale of 1 : 10,000. I also drew the contemporary coastline on that map.[11] In over half of the area the coastline has been pushed further out into the ocean by landfilling. The landfills have buried most of the cores of the two smaller levels (pools and small pools, rocks and small rocks). It goes without saying that in areas where this has happened the natural and human activities that used to be linked to them have dissappeared. So also with the brooks that connected some of the pools or lakes with the sea. None of them exists any longer; all have been put into drains and sewer-pipes.

If case-study-areas that are rich in cores are also rich in activity related to these types of cores, and if the areas with fewer cores have less richness in activity, then the hypothesis is supported by the findings. Also findings on a reversed correlation--i.e.; less richness in cores, less richness in interrelating activity--supports the hypothesis.

Chapter 6: Principle I: Unity; the Circle.

This chapter answers this question:

Does the degree of circular closure present in the meeting of adjacent urban and water-areas affect their interrelationship?

The first step in answering this question is to identify which land/water segments of the coastline most logically form a unit. Most obvious are the three harbor-areas historically located and subsequently developed (see fold-out map 2 at the end of the text). Between these harbor-areas are coastal-areas that have little harbor activity. Once all these segments have been determined on a map, a circle is drawn around them. The circle represents the ideal form for a unity and the morphological features in the areas can be checked against this ideal form. Now refer to Fig. 52 for the location of the six case-study areas defined as described above.[12]

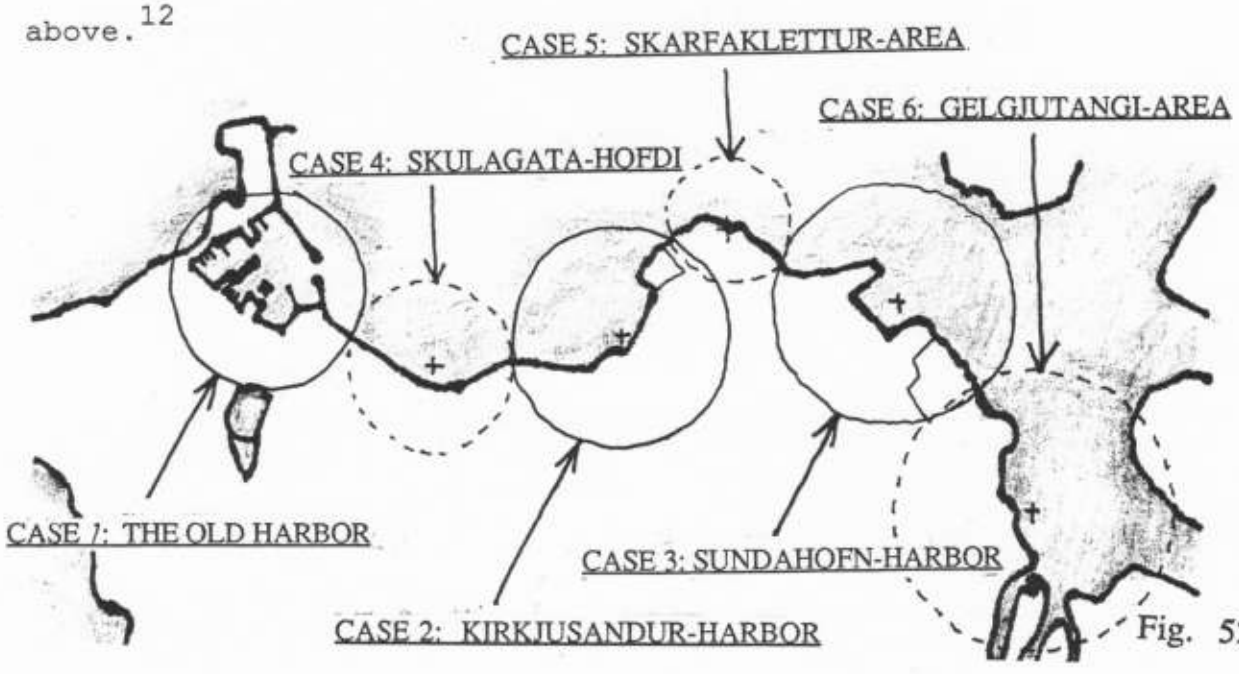


Fig. 52

As we now start to study the degree of Circle quality of the cases we have to keep in mind the description of the quality of the Circle in terms of the densest packing of elements (i.e. feature 1), as defined in Ch. 3 sec. 1. Also we have to keep in mind that the enhancement of the Circle can be achieved also by the accentuation of the Circle's secondary features i.e.: its rim, its center (focus), circular (or semi-circular) structures, steepness of land-area, and radial structures--as was explained and illustrated in Ch. 4 sec. 3. A table showing all these features will be used at the end of each of the six case-studies to evaluate the strength of their expression as seen in the maps and drawings.

The Circle-principle and the Complementarity-principle are the two principles where the increased interrelationship between areas can least be expressed by functions that tie directly to their various features. The high degree of interrelationship that occurs within an enclosure of an harbor-area comes to be because of a lessened degree of external disturbances.

The closure of the water-area (the rim of the water-side) has the function of keeping the water within the circle (the harbor) calm so that undisturbed activity can take place there even if heavy seas are outside the area. In the land-area of the harbor its enclosure (its "rim") leads to a more or less disturbed activity because the area is sheltered from e.g. unrelated through traffic. Radial streets (feature 6)

also have a physical function, i.e. to interlink the urban and the water area better in terms of transportation. All the other features have more the emotional function of enhancing the sense of unity and togetherness as explained in Ch. 4 sec. 3.

I will not repeat the explanation of these functions, and qualities of the various features of the circle, in each of the six case-studies. I will only explain those of them that either have an exceptionally strong or weak presence in the given area. Whether this strength or weakness affects the strength or the weakness of the interrelationship between adjacent urban and water areas will be discussed.

Case 1: The Old Harbor (HA1)

The old map of 1715[13] (Fig. 53) indicates that a degree of enclosure to the water-area was originally caused by natural landscape features (island, causeway, hills and lake). This accounts for the selection of this site for a harbor in ancient times. Eventually, however, the protruding land forms were inundated, resulting in the more open situation indicated on the map of 1903 (Fig. 54).[14]

Fig. 53 Map 1715

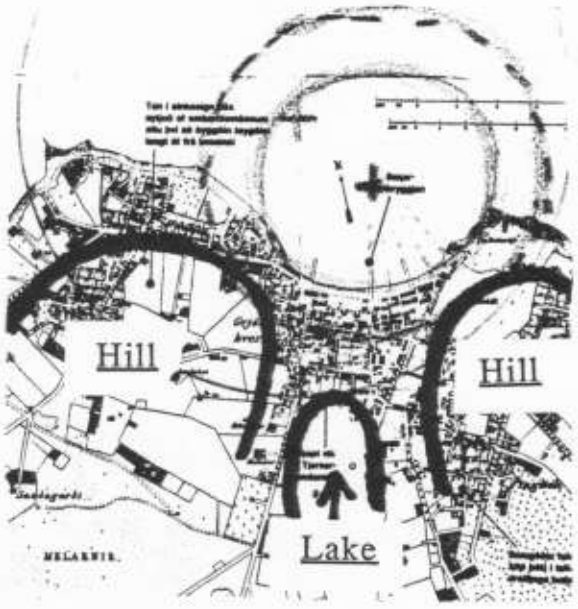


Fig. 54 Map 1903

The hills and the Lake remained, and by 1920 (Fig. 55) breakwaters had been constructed to protect the harbor activity, thus re-creating the sense of "circle." This effect has been accentuated by subsequent pier and harbor contruction which thickened the rim (map of 1982) (Fig. 56).

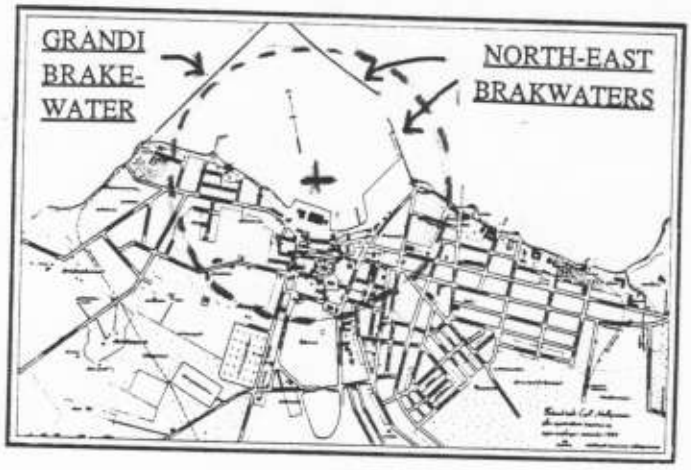


Fig. 55 Map 1920

Fig. 56 Master-plan 1982

The street pattern in the urban area has also changed over time. Many of the radial streets seen in the map of 1903 (Fig. 54) and 1920 (Fig. 55) now no longer exist (1982 map) (Fig. 56). Thus, the level of integration associated with this feature, and the accentuation of focus, once high, is now more limited.

And now I use a table to evaluate in a comparative way the presence of the features of the Circle as they appear in pictures of this section.

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape	4	8
2. The accentuation of the rim	1	7
3. The area has a focus	3	7
4. Circumf. structures that enhance the sense of a circle	6	4
5. Steepness that links land-area to water	5	5
6. Radial structures lead to the center	9	2
Final evaluation of presence	less	more

(10 represents the ideal)

Fig. 57

"Earlier" stands for 1903 but one has to look at the map of 1715 to see the causeway and the Orfirisey-island to the west and north of the harbor. "Today" stands for 1982. The numbers in the table represent my estimate of the presence of each criterion, 10 being the ideal.

Criterion 1 is weighted most heavily, and has the greatest influence on the evaluation of the Circle's overall effect. My conclusion is that the Circle is more present today than

earlier, and that because of that, the interrelationship of the urban and the water has been enhanced. The increased degree of functional interrelationship is dealt with in Chapter 7, Case 1.

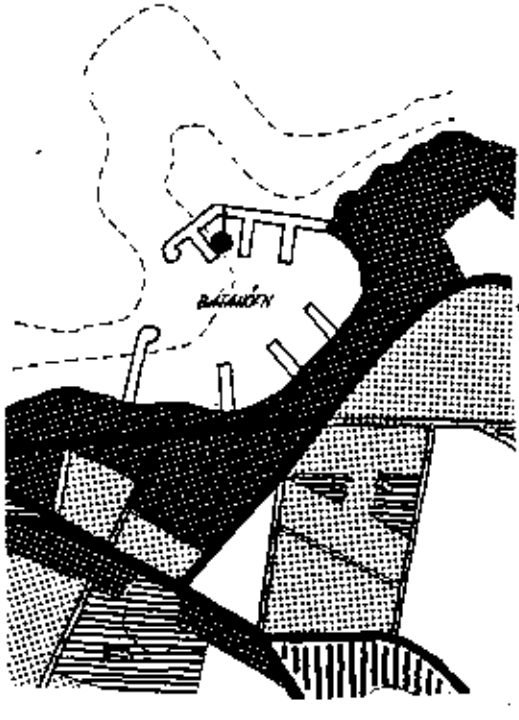
Case 2: Kirkjusandur harbor-area (HA2)

Before a closed harbor in Reykjavik had been constructed no particular advantage was gained for fish producing plants to be located inside the village. When fishing-smacks (large sail-boats) started to be used (after 1866), the movement of fishing plants to outlying locations increased because the plants required large amounts of space, especially plants that conserved fish by sun-drying it.

The North Coast, all the way to Laugarnes, became filled with such fishing companies and other industrial facilities, most of them having private piers going out into the ocean. Fig. 58 shows the Th. Thorsteinsson-plant on Kirkjusandur at the turn of the century.[15]

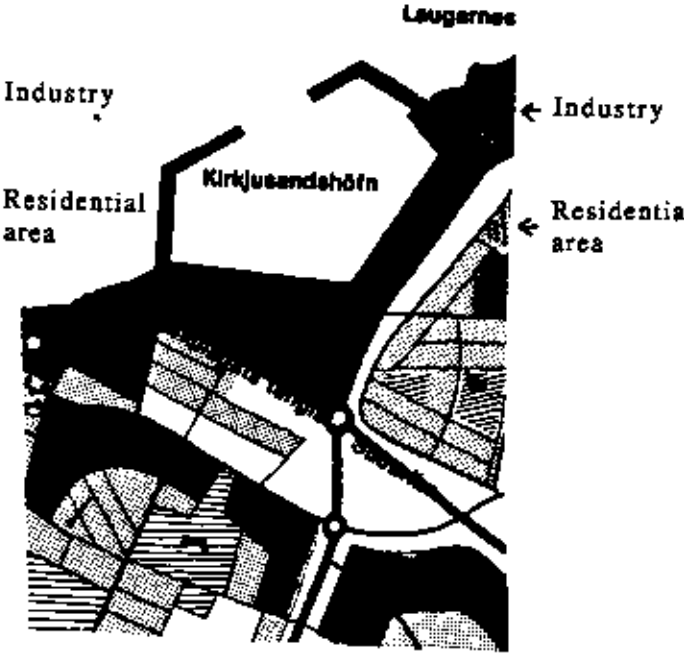
Fig. 58 Kirkjusandur around 1900

When cooling techniques were improved, through the introduction of freezing machinery around 1920, the importance of sun-drying plants was reduced. Also, the securer operation in the safe harbors available at Reykjavik and Videy island made the unstable operations on the coast less competitive. As a result, the idea of building breakwaters at Kirkjusandur began to be considered. A harbor was shown in a plan of 1948, and also appeared in the 1957 plan. See Fig. 59 and Fig. 60.



Master-plan
1948

Fig. 59

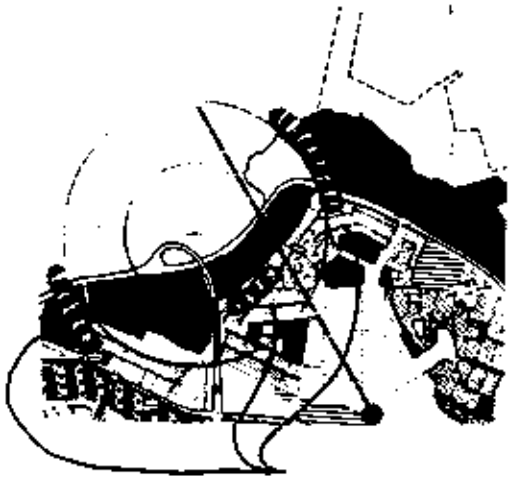


Master-plan
1957

Fig. 60

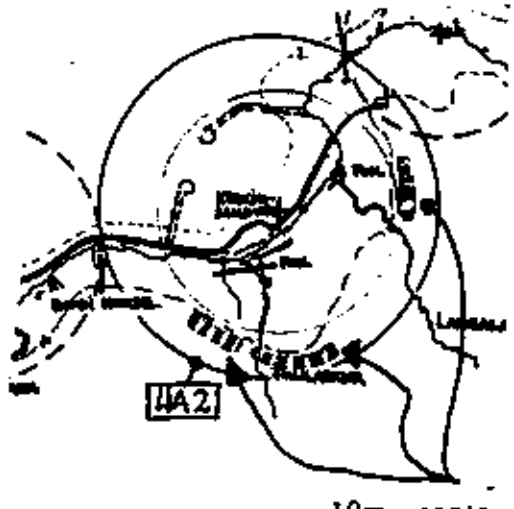
The dark grey shading on these maps shows that only industrial activities were supposed to be located at this harbor (light grey shading signifies residential areas). In accordance with this plan, a modern fish-plant (Jupiter-Marz) and a meat producing plant (SIS) were built here in the 50's. The fact that the harbor was never built here as planned, has led to significant additional transportation costs for these companies.

The land-use in this area has not changed much as we see on Fig. 61. We also see here that the shape of the industrial area helps somewhat in defining a semi-circular pattern on the land half. The concavity of the shore has, however, been somewhat reduced by a landfill, which leads to a lessening of the circular definition of the water-area. On land, geographical contours help in underlining the circle, as can be seen in Fig. 62 (dotted line).



Shapes of land-uses help define circle

Fig. 61 Master-plan 1982



10m contourline helps define circle

Fig. 62 Morphol. features

This discussion has helped us realize how the lack of a closure in the water-half of this area (i.e. the lack of shelter for ships) has led to severe functional drawbacks in terms of the interrelation between the land- and water-area here.

A detailed evaluation of the various circular features is provided by the following table. The differentiation between "Earlier" and "Today" is given for further clarification. As in the previous tables of this type, the numbers are my estimations of the presence of the features in question, 10 representing the ideal.

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape	4	3
2. The accentuation of the rim	2	1
3. The area has a focus	3	2
4. Circumf. structures that enhance the sense of a circle	4	4
5. Steepness that links land-area to water	3	3
6. Radial structures lead to the center	3	2
(10 represents the ideal)		
Final evaluation of presence	more	less

Fig. 63

Case 3: Sundahofn-harbor (HA3)

As the down-town area of Reykjavik continued to develop as a city center, the areas around the harbor, that had provided space for harbor related activities, were taken for other types of activities. This, together with increased imports

to Reykjavik in the boom after the Second World War, made it obvious in the 50's, that a new cargo-harbor was needed.

Over-enthusiasm and lack of professionalism in planning led to overblown harbor ideas. The next two pictures show harbor proposals from election booklets of the ruling party (the Conservatives), in the City Government, in the election years 1958 and 1962.[16]

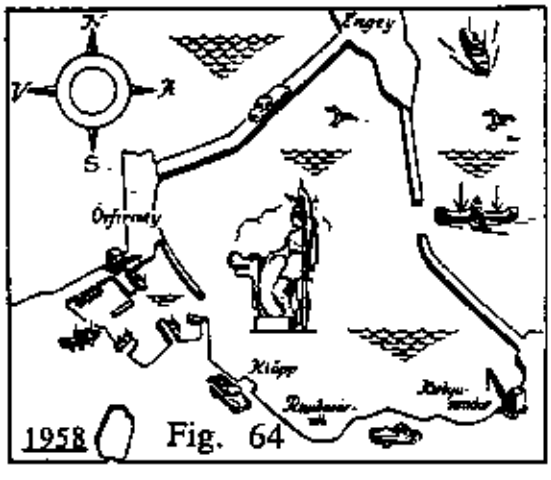


Fig. 64

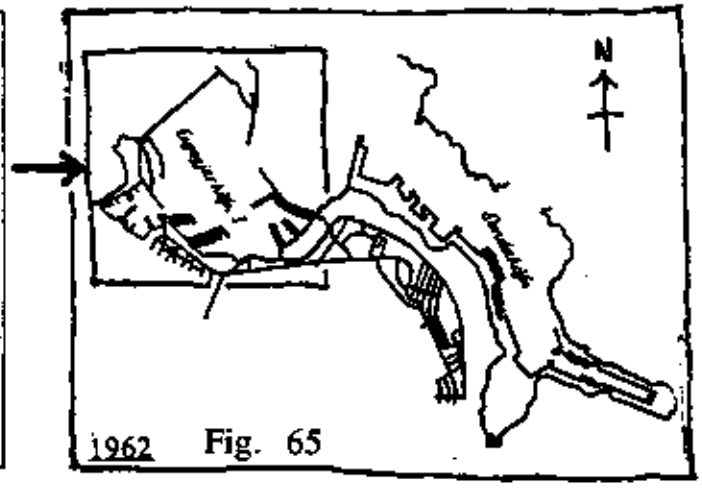


Fig. 65

In the picture to the right a harbor in the sound appears for the first time. The first secion of this harbor was taken in to use in 1968 (marked with grey on the next map).

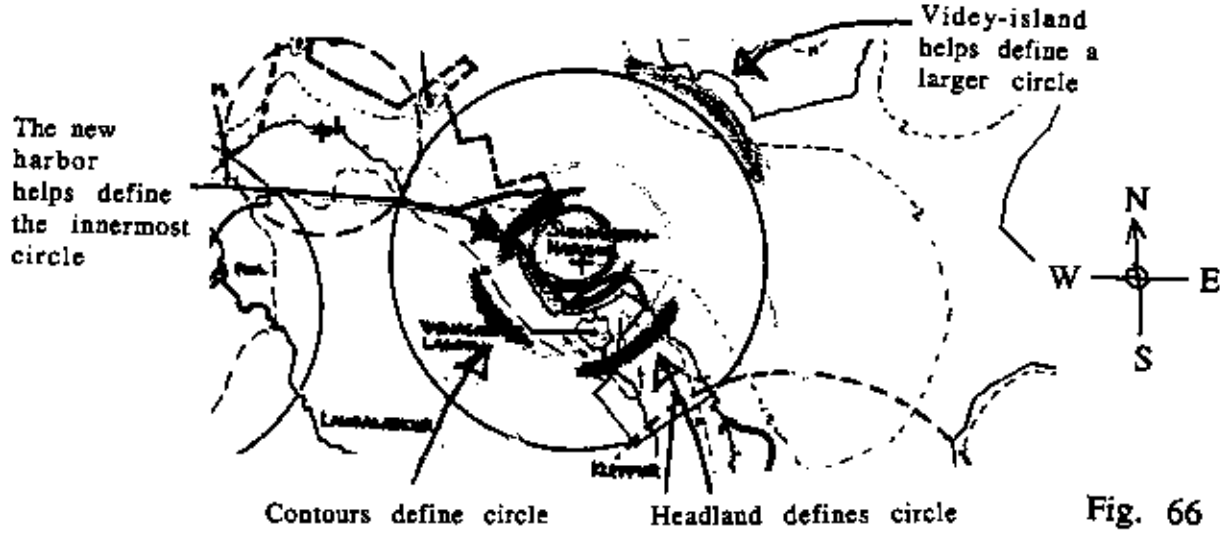
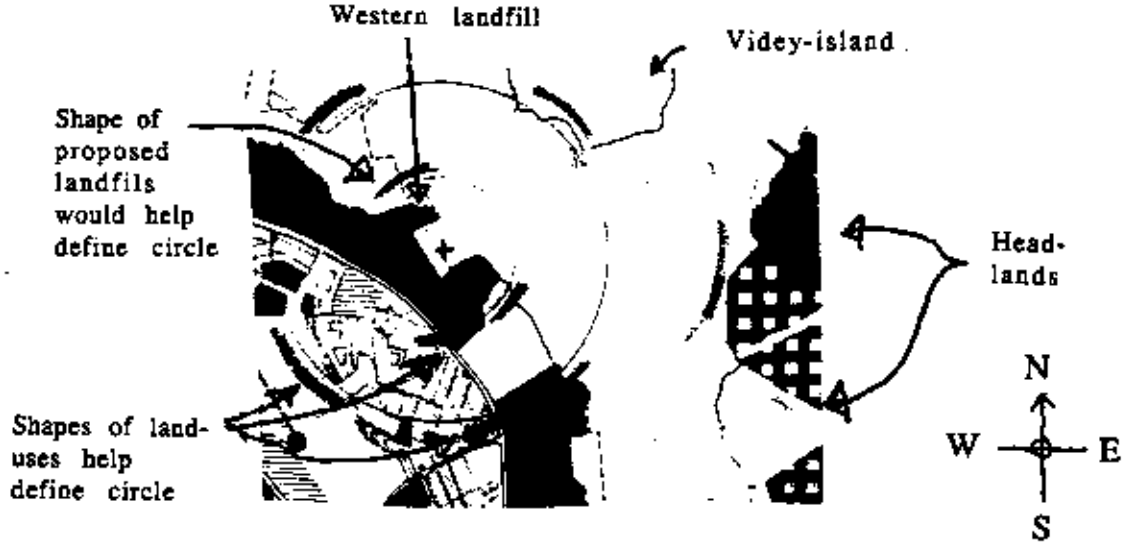


Fig. 66

As we can see, on this last map, the increased concavity -- the U-shape of the harbor -- helps define a circular shape of the water-area, and a larger circle is defined by the Videy island. Breakwaters are not needed because the sound is narrow: enclosed by the island and two headlands (to the east). On land, topographical contours to the east help somewhat in the defining of a semi-circle.

As the following 1982 map shows, the land-uses and the roads help little in defining this central area of the harbor.



Master-plan 1982

Fig. 67

In summary one recognizes that the Circle is present here, not because of brakwaters but because of the island to the

north the headlands to the east. This together with the landfill to the west of the harbor creates enough closure to allow harbor-activities to take place here most days of the year.

The following scheme gives an overview of my comparative evaluation of all the features of the Circle. (10 again representing the ideal.)

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape	6	7
2. The accentuation of the rim	5	6
3. The area has a focus	5	8
4. Circumf. structures that enhance the sense of a circle	5	5
5. Steepness that links land-area to water	5	5
6. Radial structures lead to the center	4	3
(10 represents the ideal)		
Final evaluation of presence	less	more

Fig. 68

Case 4: Skulagata-Hofdi Area (CA1)

This area started to develop strongly in the last decades of the 19th century. The map[17] (Fig. 69) from 1903 shows the area, but the map does not reach quite east to the Hofdi-house.

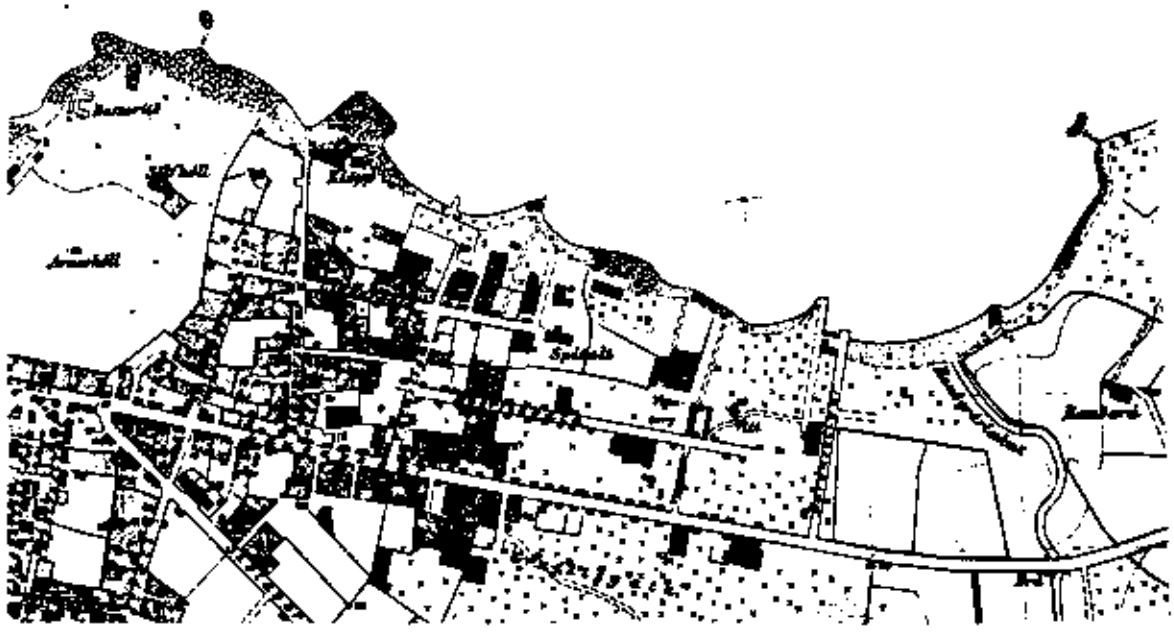
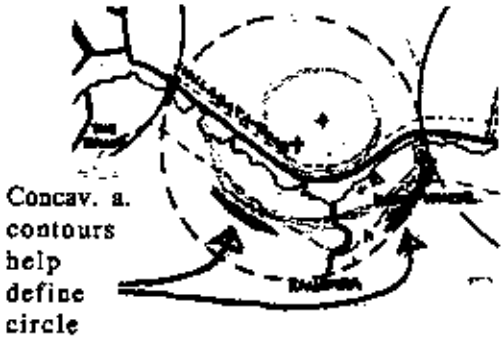


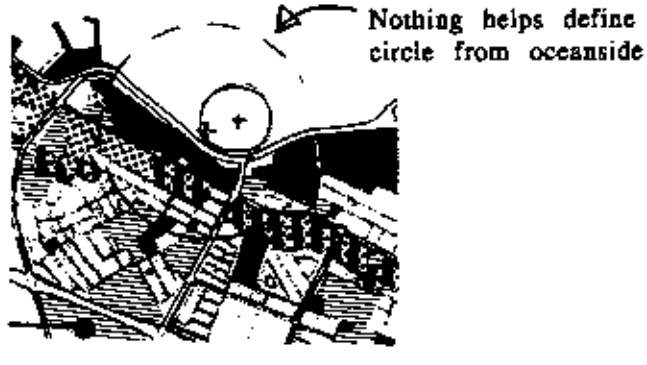
Fig. 69 The coastline where today's Skulagata-road is located

The map shows a few piers that represent the connection to the water from the fish and industrial plants on the coast. As Fig. 70 shows, not many features help define the water semi-circle unless one counts the two convexities to the sides of the area and the slight concavity of the coast. This concavity has today been reduced by the landfill (see the thick line which is today's coastline).



Morphological features

Fig. 70



Master-plan 1982

Fig. 71

As Fig. 70 shows, contours in the topography help define the land half-circle - as does the concavity too. The shape of land-use areas and the roads (see Fig. 71) are of little assistance in defining the urban semi-circle. The newest land-use ideas for this area include a residential area (city-flats) in the western part, but little attempt is made to connect this project to the water. (See two early sketches from 1983).[18]

Fig. 72 Highrises at the coast (prop.)

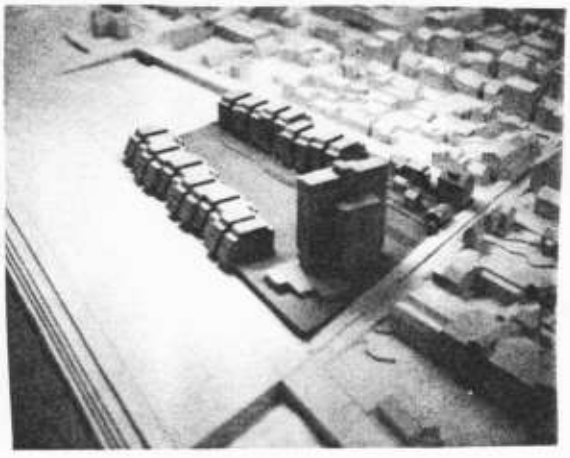


Fig. 73 Lower buildings (prop. '83)

As this case-study has demonstrated, the degree of circular closure in this area is low already from the shape of the original topography. Most man-made structures in the area give little, if any, support to circularity in this area. That the radial streets have been cut off at the shore, both reduces the focusing effect of such streets as well as reduces the functional interrelationship between the urban area and the water, because such radial streets are channels for connecting functional-activities between the urban and the water-area.

The following scheme gives an overview of the features of the Circle where the numbers show the relative strength of their expression. (10 representing the ideal).

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape	3	2
2. The accentuation of the rim	1	1
3. The area has a focus	3	2
4. Circumf. structures that enhance the sense of a circle	4	3
5. Steepness that links land-area to water	7	7
6. Radial structures lead to the center	6	4
Final evaluation of presence	more	less

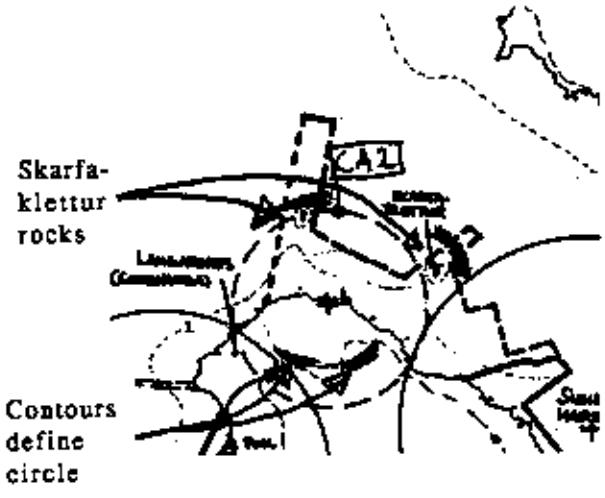
(10 represents the ideal)

Fig. 74

Case 5: Skarfaklettur-Area (CA2)

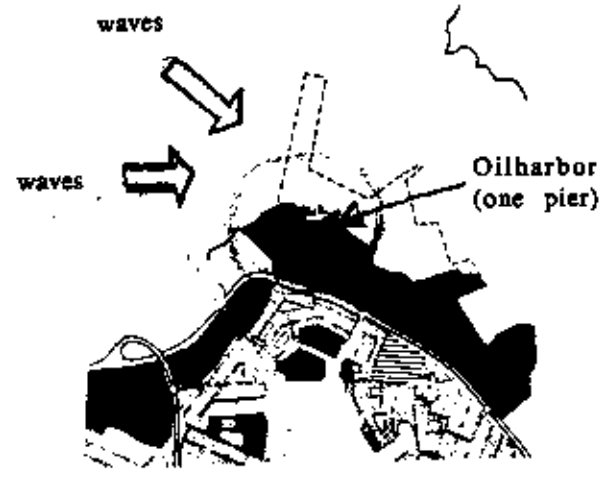
This area has a convex coastline which is a negative quality in terms of connection between land and water -- a concave coastal area, in contrast to this, embraces the adjacent waterbody.

Offshore are, however, two prominent rocks -- Skarfaklettur (east) and Small-Skarfaklettur (west) -- that help somewhat in the defining the water-area (See Fig. 75). This picture also shows that the proposed huge landfills (a heavy dotted line) would submerge these rocks.



Morphological features

Fig. 75



Master-plan 1982

Fig. 76

The contours on land help a little in defining the land-area's semi-circle and so does the shape of the industrial area. Although the circle is not enclosed toward the ocean an oil-harbor is located here. The lack of closure makes its operation difficult. Other water-related activities are also difficult here because of the openness to ocean-waves coming from the west and north-west.

The following scheme shows an evaluation of the basic quality of the circle (feature 1) and also an evaluation of the secondary features of the circle (features 2 to 6). Earlier stands for the time before any man-made structures existed in the area (i.e. only the topographical features). Today stands for 1982. (In the evaluation 10 represents the ideal).

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape	1	1
2. The accentuation of the rim	3	4
3. The area has a focus	1	1
4. Circumf. structures that enhance the sense of a circle	1	1
5. Steepness that links land-area to water	2	2
6. Radial structures lead to the center	1	2

(10 represents the ideal)

Final evaluation of presence	less	more

Fig. 77

Case 6: Gelgjutangi-Area (CA3)

The eastern-most part of the North Coast ends at the estuary of the Ellidaar salmon-river. The estuary used to have large mudflats. They have now all been submerged by huge landfills. As the map shows, the area is protected from waves, except for fjord waves (and wind waves) from the north.

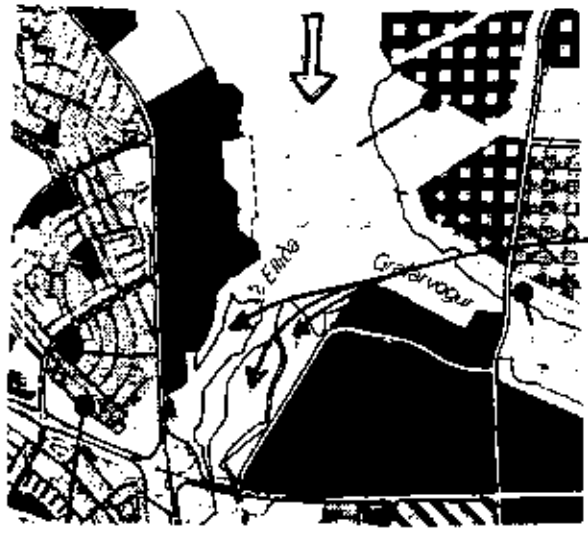


Fig. 78

Master-plan 1982

The circle in the next picture points out the enclosing quality existing in this narrow fjord. These landscape features, however, do rather little for the interrelationship of the water-area to any one of the adjacent land-areas in particular.

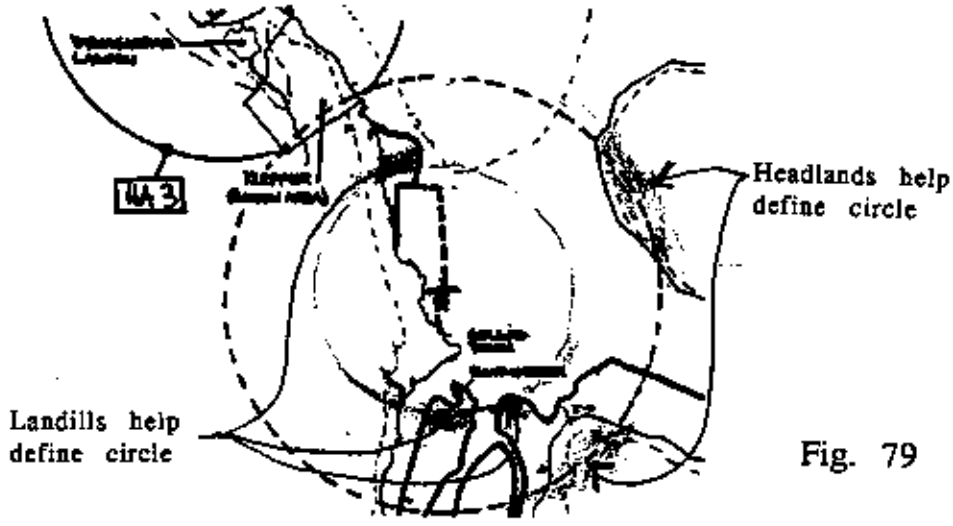


Fig. 79

The shape of the Gelgjutangi coastline is convex and so are the geographical contours of the adjacent land-area too. They therefore do not help in embracing the water-area outside. Land-use areas and street patterns do not help much either in the accentuating of the circle, as could be seen on the master-plan map (Fig. 78).

The enclosure that the islands and the headlands form in the water-area, allow undisturbed harbor-functions to take place here most days of the year. The circle quality on the land-half of the area is, on the other hand, poor. This is a contributing factor in how little interrelation the urban area has to the water area.

An evaluation of the presence of the various features of the Circle is given in the following scheme. (10 representing the ideal in the evaluation.)

Features that contribute to the richness of " Circle "	EARLIER	TODAY
1. Approximation to a circular shape	6	6
2. The accentuation of the rim	4	5
3. The area has a focus	2	2
4. Circumf. structures that enhance the sense of a circle	1	1
5. Steepness that links land-area to water	4	4
6. Radial structures lead to the center	2	3
(10 represents the ideal)		
Final evaluation of presence	less	more

Fig. 80

Summary and conclusion of the findings of the six case-studies on the Circle

At the end of the thesis a large matrix (a fold-out) summarizes the findings of the case-studies. The degree of functional interrelationship between land and water within the six case-study areas is evaluated there. Part of this grid (Fig. 81) is now used to show how the six case-study areas rate in terms of how much or little present the circle is and how strong or weak the overall functional interrelationship between land and water is.

The three sizes of X indicate three intensity grades of the interrelating activities. The evaluation (presented in the

fold-out) has not been described in this chapter because it is the culminative effect of harbor constructions that leads to increased harbor activity, not specific features of the circle. This cumulative effect (or lack there of) builds up with data and descriptions in the other chapters of the case-study.

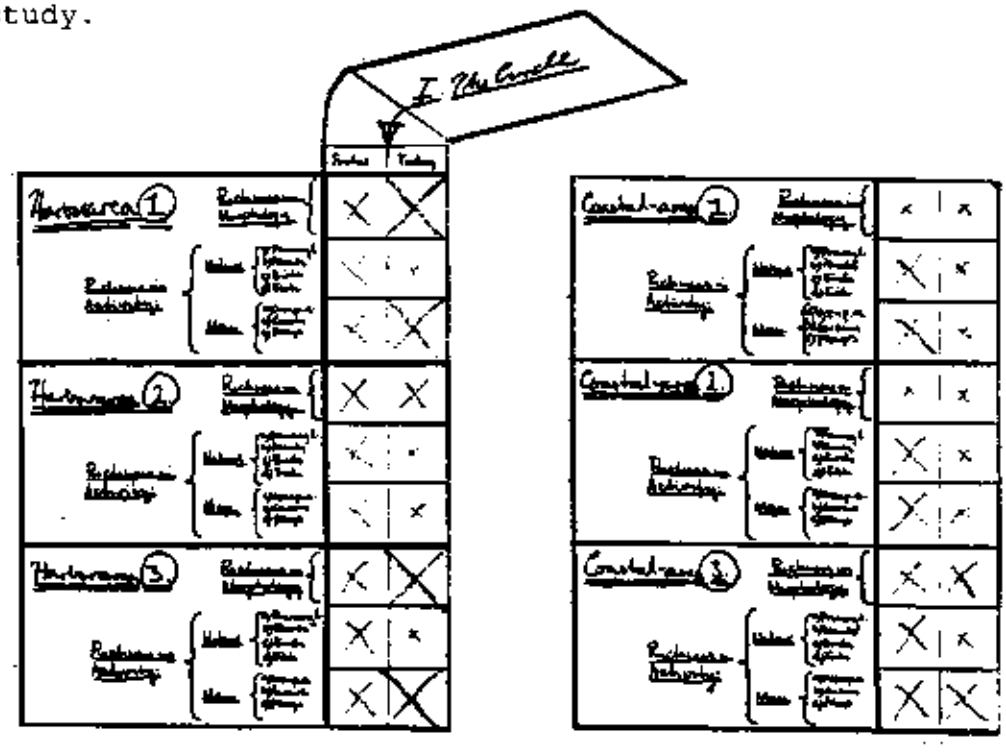


Fig. 81

These comparisons in the matrix build the basis for me to place the six cases in the cells of the following scheme.

		Circular form	
		more present	less presen
Inter-action	strong	HA1 HA3	
	not so strong		HA2 CA1 CA2 CA3

Fig. 82

These results answer Question I positively: yes, the more present the circular form that a pair of two adjacent urban and water areas form together, the more the interrelation of the two areas is enhanced.

CHAPTER 7: Principle II: A Dynamic (concave/convex) line.

This chapter answers this question:

Does the amount of richness in the concave/convex quality of the coastline affect the amount of ecological and human activity?

The definition of the term "richness in the concave/convex quality" is given in Ch. 4, sec. 3. There I distinguish between three levels in size: 1. Macrolevel (half-circles 700 to 1500m in diameter) 2. Medium-level (half-circles 100-200m in diameter) and 3. Microlevel (half-circles 5-10m in diameter).

In each of the case-study-areas I demonstrate how the two first levels (macro- and medium-levels) appeared earlier and how they appear today. Then I give examples of how various types of activity used to be linked to the concavities and the convexities on the coast. The suggestion that I am testing here is that many of these activities were so dependant on these form-qualities that they automatically disappeared as the facility provided by the form (e.g. a landing place for boats), disappeared.

The third level (microlevel) can not be analyzed with the help of maps because these micro-forms are too small to appear there. However, the creation of landfills by dumps and bulldozers, has destroyed the fine-structuring of the

coast-line, that was formed by geological and hydrological forces over thousands of years. These structures will not be recreated in landfills except with detailed landscape plans. Most today's landfills, on the other hand, simply follow a straight line. (See two photos for comparison).

Fig. 83 Natural coastline

Fig. 84 Landf. coastline

On the maps in the sections written on each of the six areas, I point out the convexities and concavities (of level 1 and level 2) by drawing half-circles where they are located at the coast.

The following picture shows concavities and convexities on level 1 for the whole area, for the purpose of an overview. (The three grey large half-circles show a superlevel that is not dealt with in this study.)

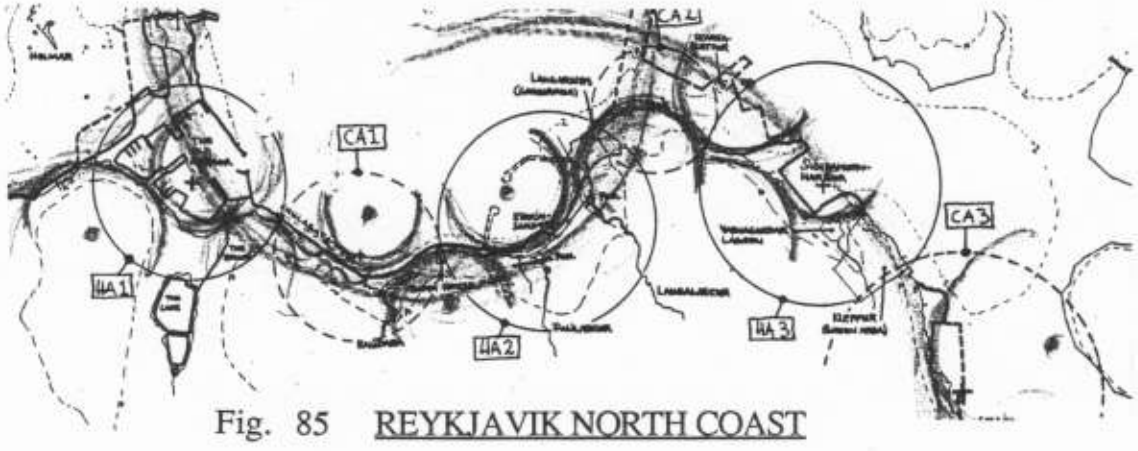


Fig. 85 REYKJAVIK NORTH COAST

An overview of the methodology used for determining a richness of concaveness/convexness (on the three levels of scale) has now been demonstrated. When it comes to the direct use of these form-qualities of the coast by humans (like for instance concavities for landing places for boats) we see that the richness in activities, is directly related to the existence of these forms.

The data I have gathered on richness in biological activity (which mostly shows a decline) can to a certain degree be seen to be linked to the decline of physical qualities of the coast. An example of this are data collected at the Icelandic Institute of the Nature Sciences on the number of birds in the study-area.[19] Birds at this coast have been counted at year's end for about 30 years. I plotted diagrams for nine of these bird species. Most of the diagrams showed a clear parallel in the time-scale between a decline in the number of birds at the coast and the process of landfill in the area.

The head of the bird-division, Aevar Petersen, has reported on the trends that appear in the diagrams. Petersen's report[20], however, only linked the decline of the oyster-catcher species directly to the loss of the mudflats in concavities on the coast and in the Vatnagardar-lagoon. Other species like the ducks are able to substitute food they earlier found in the mudflats by other food sources like that of the totally untreated sewer discharge close to the coast.

In still other cases he suggests that the food is not the

critical variable; population numbers of birds variate for other reasons, and often the ornithologists do not know why, because the ecological systems are so complex, and often reach to other countries where unknown factors might be at work. Petersen's most conclusive suggestion was that the increased traffic and noise in the area had driven the more wary species away. These species are the more popular ones (e.g. some duck species) whereas the species often associated with sewers, dumps and people (e.g. sea-gulls), have been on the increase.

This development is therefore in any case negative in terms of birdwatching activities (fewer birds of the popular bird species, and also less visible because they sit now rather on the water than on the coast). This is also negative in terms of the decline of the positive image that Reykjavikians used to have of this water-area and is a contributing factor in the decline of the emotional relation of people to the coastline.

In a recent inventory on all types of natural features in the Greater Reykjavik Region, conducted by the IINS[21], new data are put in tables for comparison with older available data. Most of these data show a trend towards decline in diversity and volume of natural processes. I will in the following give an overview of the most significant trends. These data are an indicator of lessened relations between land and water in the area, because man relates to the islands to a certain extent (both functionally and

emotionally) because of the biological diversity and richness in these zones.

Higher plants:[22] From the 125 species counted in 1939 in Videy-island, 26 had disappeared as a new count was conducted in 1984. Twelve new species had, however, come in their place. This is a decline of 14 species in this 45-year period. In Engey-island 95 high-plant species were found in 1939 but 71 species 45 years later. This is a decline of 22 in number of species, because for the 33 species which had disappeared in 1984 11 had come in their place.

Nesting birds:[23] In Videy-island the number of nesting birds species was 27 in the years 1970-77 (the average number of bird species in these years). In 1984 this number had declined to 23, which is a decline of 4 species. In Engey-island parallel numbers are 20 species in 1970-77 and 15 species in 1984, which is a decline of 5 in the number of species in this short period of time. Egg-collecting is still a popular activity in the Reykjavik-area and this decline means a lessened diversity in that activity.

Eider-down: At the turn of the century the harvest of this very valuable resource was 20 kg in Videy but is only around 3 kg today. Parallel numbers for Endey are 40 1/2 kg and 2 kg.[24] This resource is fully harvested today and the nesting areas are protected during the nesting season. Therefore these two factors can not have a role in the decline in these numbers.

Lumpfish catch: The Innnes-report gives the amount of roe

produced by the lumpfish catch for the following years[25] : 1978 - 207 tons, '79-340 tons, '80-302 tons, '81-198 tons, and 1982-125 tons. This is a decline of some 40% between the first and the last year. The areas where the fishermen did put their nets in 1978 (traditional spawning grounds) are shown on the following map:

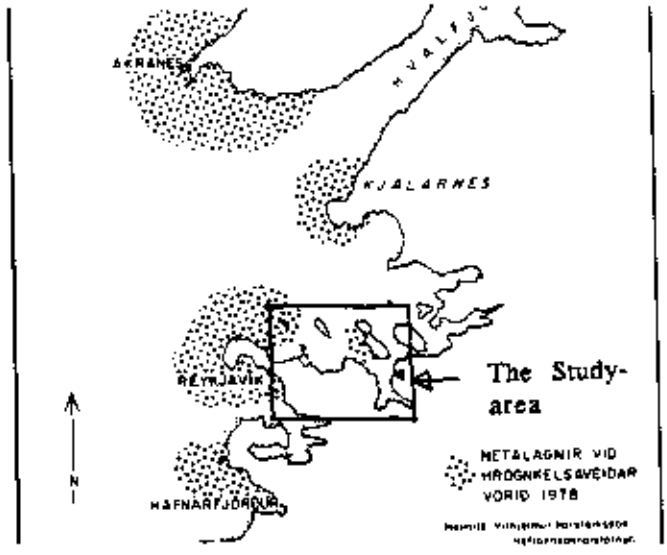


Fig. 86

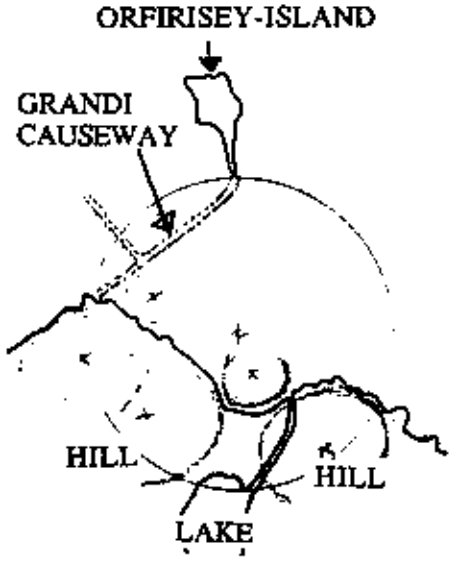
Placement of nets for lumpfish catching in 1978 (Innnes Report p. 71)

Let us now turn to the analysis of the six case-study-areas in terms of morphology and activity in each of these areas. Most of the data that exist on nature-activities of specific sections of the coast, applies for other segments of the coast as well. These data are, however, only mentioned once in the text i.e. in the section where they come from. The same applies for the human activities. Here one should, however, keep in mind that parallels can not be as easily drawn, because the intensity of man's activities differ with the accessibility to the coast and with the size of population in the area adjacent to the given section of the coast.

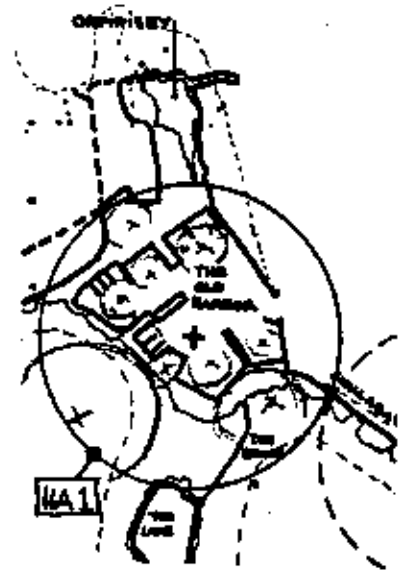
Case 1: The Old Harbor (HA1)

Because of the complexity of the man-made harbor constructions in this area the analysis of the convex/concave qualities will be examined in two steps - i.e.; the convexities and the concavities in earlier times, and the convexities and concavities today.

Each of these two studies of the shape of the coastline will be followed by an overview of what activities are typically linked to these shapes. For clarity I present here two small drawings placed side by side that show the area earlier (in 1903) and today. As the first drawing shows, the harbor area had earlier one clearly formed concavity and two convexities on the macro-scale. The second drawing shows how the number of micro-concavities and convexities has been increased by the harbor contructions in this area.



In 1903 Fig. 87



In 1982 Fig. 88

Comparison of the number of convexities and concavities in the Old Harbor in two periods of time

Let us now take a look at the 1903 map in a larger scale in order to be able to discern how the medium-level convexities and concavities of the coastline used to appear.

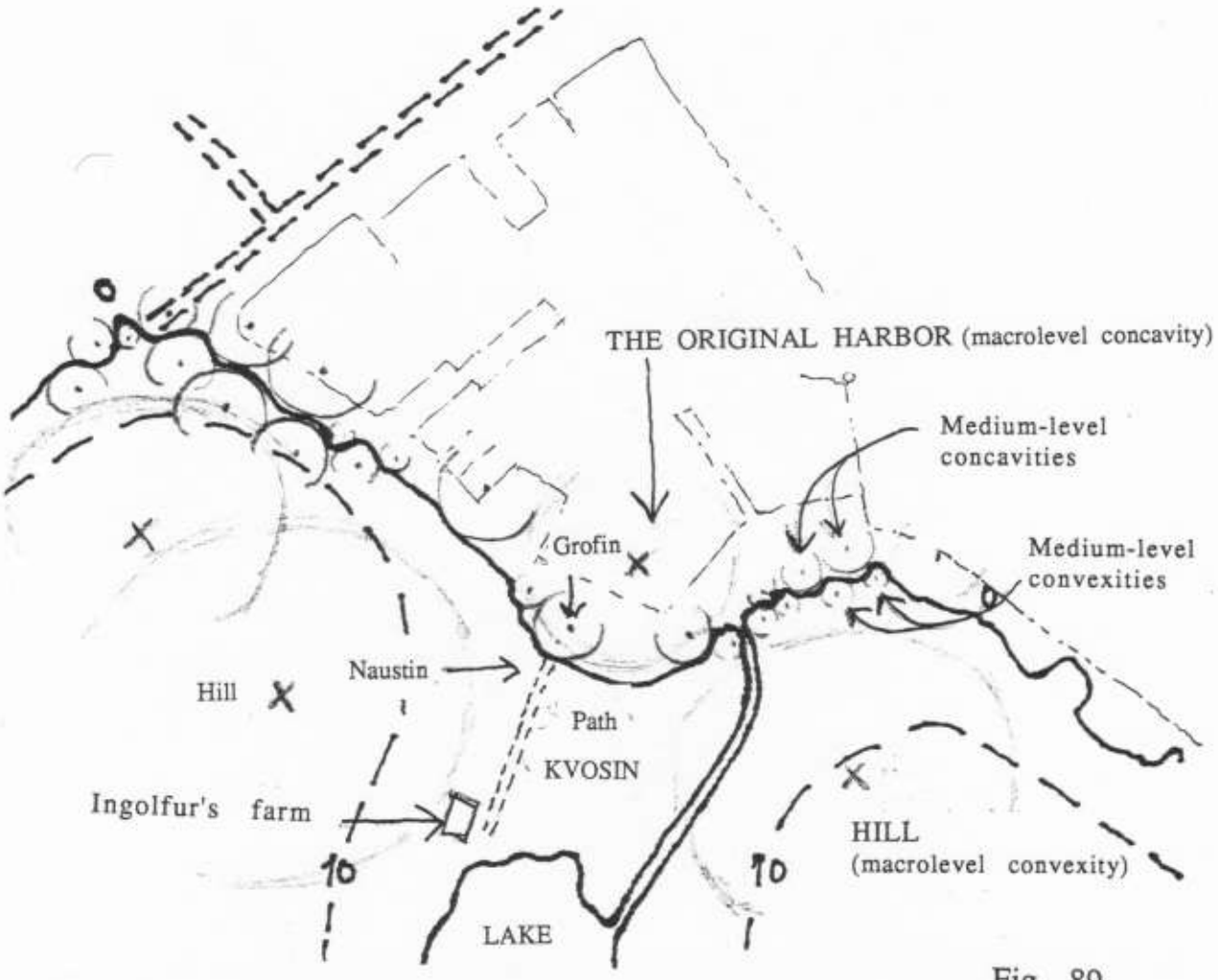


Fig. 89

The macro-level concavity of the water-area was the original "harbor" flanked by the two macro-level convexities. This concavity was a flat sandy beach with one middle-level concavity -- Grofin -- to its west side. There, on the beach -- on a piece of land called Naustin -- most of the fishing boats were kept in early times.

This, most scholars think, was the "harbor" of Ingolfur,

the first settler, with a path leading from this concavity to his farm at the north-end of the Lake. Scholars are not sure whether this concavity was called Reykjavik (which means Smoke- or steam-, inlet or bay) or whether the name referred to the large concavity of the North Coast. But, anyway, the town takes its name from a water-area, a concavity, like most other towns in Iceland, which is an indication of the importance of water-areas in earlier times. Because of the 1 to 1.5m subsidation of the area in the last 1100 years, the coastline must have been further (some 50-100 m) out into the ocean, but its shape might, though, have been similar.

As the village started to spread out of the neck of land called Kvosin, in the 19th century, many of the new Reykjavikians settled close to the coast-line east and west of the old village. The following drawing[26] shows such "farms." Some of them did not have cows and were thus called dry (no milk) farms (thurrabudir). The drawing does not show the many boats that were kept in the concavities.

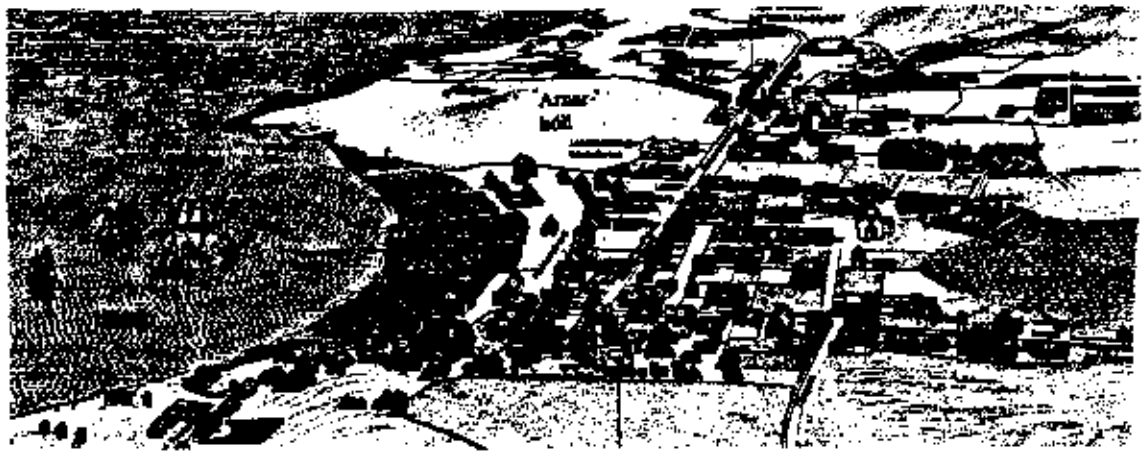


Fig. 90 Reykjavik in 1876

On the following map I point out the location of the boat-concavities, although some of them are barely visible on the map. Also I mention the approximate number of boats in each "vor" (which is the Icelandic word for such concavity, they also had specific names shown on the map).

These data are taken from an essay by Th. Thordarson based on his series of interviews in 1934-35 with O. Jonsson, a fish appraiser who lived in the area.[27] His accounts were checked by two other old Reykjavikians. The data reflect the latter part of the 19th century. The map is from 1903.

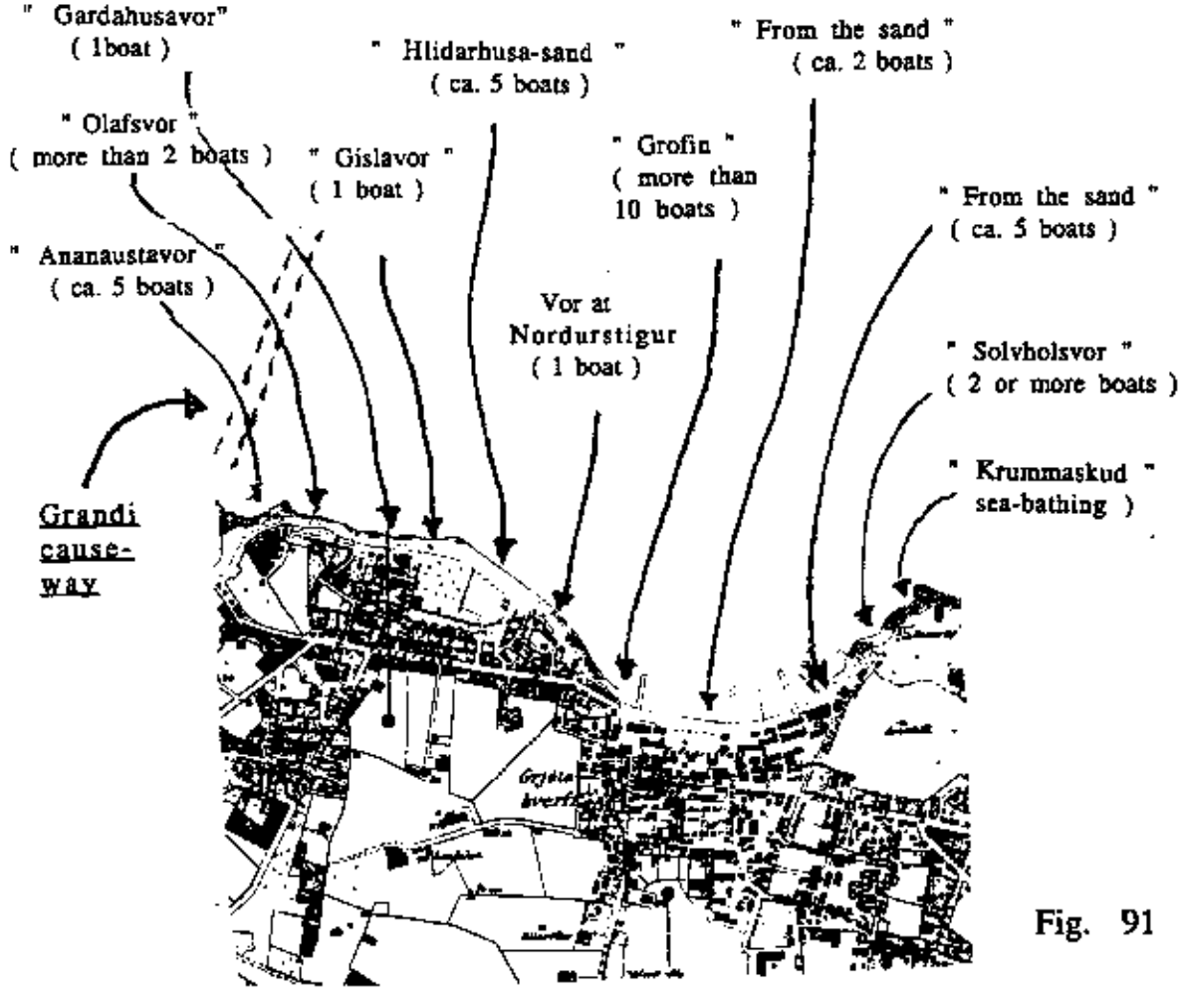


Fig. 91

These concavities were actually more prominent than appears on this map because on the sides of them usually rocks or reefs stretched out in the sea. Their shape was also enhanced by man by the moving of rocks from the middle section of the concavities in order to make them more accessible for landing places.

The vor-areas were exchangers; i.e. there exchanging and interrelating activities between land and water took place. H. Ottosson explains:[28]

> The fish from the boats was thrown ashore. As a boat was expected at the Hlidarhusavor, one could see housewifes and youngsters walk towards there with buckets to get heads, liver, stomachs and roe for cooking. Payment was seldom given. . . (p.102).

Another byproduct of the curing, that often took place at the shore, were fish bones which were dried and used for fuel as was seaweed. Fish byproducts and seaweed also provided food for animals in the winter, notably ponies. (See the photo).

Fig. 92 Ponies feeding at the coast (~1890)

The reefs at the end of convexities were often rich in seaweed, but if sheep were kept for feeding on these reefs and skerries, children frequently had the task of bringing the sheep on shore before the reefs got submerged at high tide, to prevent them from drowning. Some of these skerries had dulse, "sol," which was important food for humans. Children (mostly boys) used to angle from the coast either from rocks or skerries. The weed and primary life on these rocks attracted coal-fish whereas plaice was the main species at the pier ends.[29] Sometimes small cod (tharathyrsklingur)[30] could be caught in the seaweed and lumpfish on flat beaches and pools at the ebb tide.

As an indicator of the importance of natural resources and their relative distribution I publish here a table[31] that shows to which degree (%) the farms in the Greater Reykjavik Area possessed such sources in 1703-1704.
Sources that are frequently linked to the shore are marked with an X, those sometimes linked; x. The notes indicate to which form-features these resources are most frequently connected.

	Resource	Possesed by . . . % of farms
	1. Turf	79
(concav.) x	2. Peat	77
(concav.) X	3. Hope for driftwood	44
(concav.) X	4. Lumpfish-coast	42

(convex.) X	5. Dulse-coast	38
(concav.) X	6. Shellfish-coast	33
	7. Bruches (for fuel)	30
(concav. a. X convex.)	8. Beach-plants	25
(convex.) x	9. Trout	21
(convex.) x	10. Salmon	13
	11. Ling (for fuel)	13
	12. Trees for coal-making from common lands.	10
(convex.) X	13. Seal-catch areas	8
	14. Berries	6
(cores in w. x cores in l.)	15. Eggs	5
	16. Turf for fuel	3
(concav. a. X convex.)	17. Seaweed for fuel	1
(cores in w.) X	18. Fowl-catch (Puffin)	1
	19. Heather plants	1
(cores in w.) X	20. Down	1

As we now have discussed the coast at the Old Harbor in its original state, we proceed to discuss the man-made harbor that was closed off in 1915.

Fig. 94

Most of the build-up of piers shown on this drawing, took place from 1915 up to the end of World War II. The length of the piers at 5 m low water-mark was 240 m in 1918 and 1271 m in 1944 (in addition to that the harbor also had piers for boats and small ships). The amount of harbor activity increased with the increased length of this interface. The year 1918 had 361 ship visits (82,000 reg. tons netto) and year 1944 1600 ships (964,000 reg. tons netto).[32]

The harbor constructions soon started to fill up the old boat-niches. On this the following report from the Morgunbladid-newspaper on January 14, 1916:

> Before landfills were started on the beach in front of the town center there were many places where boats could be pulled on shore, but now not a single boat can be put on shore anymore.
> --They (boatowners) asked that (the town authorities) had the concavity at Litla-Sel repaired so they could land there (p.1.).

In the earliest period of this harbor, the area at the water's edge was still an interface where the general public was connected to the realities of the water in some way.

This area, for instance, had a fish market (see the photo) where also agricultural products were sold.[33]

Fig. 95

Fishmarket in 1919

The State Coastal Service (Rikisskip) was given space in the West-harbor. This company is still in operation but has few passengers today. Arrivals of passenger ships coming or going to other countries were a big event in earlier times. This type of activity came to halt in the late 60's. Today, visits by foreign cruise-ships are on the increase and the car-ferry to Akranes (some 50km away) is widely used by the general public. Fishing activities have been moved to the west side of the harbor on landfills that have little contact to urban areas. The cargo depot in the east part of the harbor has little contact with the city center. This activity is on the decline since Eimskip started to move its operation to the Sundahofn-harbor after 1968 and since the bankruptcy of Hafskip in 1986.

In 1986 a proposal for a "Good-Mood Harbor" in the S-east corner was presented. In this area one could establish "exchangers": restaurants, fish markets, tourist center etc. that can help interrelate the general public (the urban area) to the water-area, i.e. if this activity is given enough space in the interface.

Overall the interrelation of land and water has increased in this area (HA1) which can be summed up in the fact that an interface of 1.3 km has been extended to 4.5 km, which is an increase of 3.2 km.

Case 2: Kirkjusandur Harbor-Area (HA2)

As the following map shows the macrolevel Kirkjusandur-concavity has been somewhat reduced, the Hofdi-convexity has

been largely lost, but the Laugarnes-convexity is still preserved.

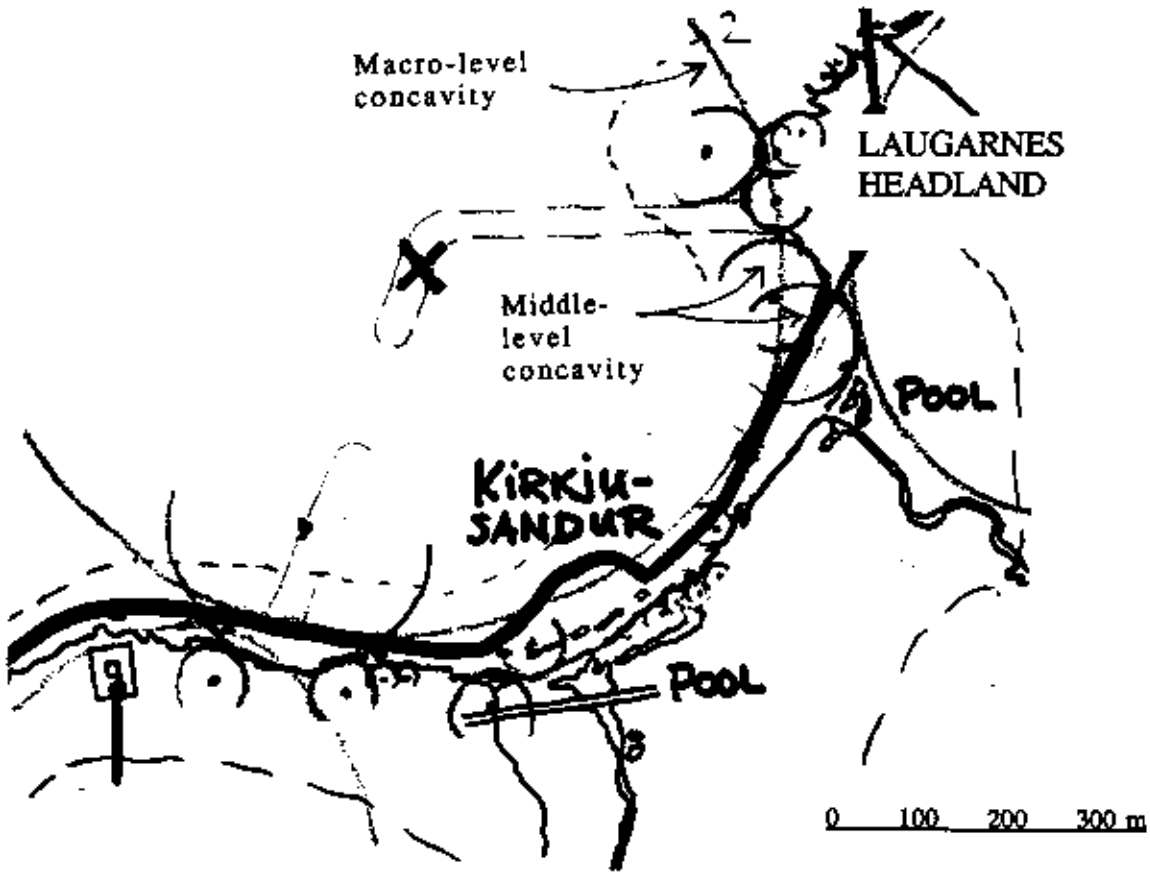


Fig. 96

On the middle-level all conv./conc. have been lost except on the Laugarnes headland. The same applies to conv./conc. forms on the micro-level although this can not be seen on this map.

Among the traditional coastal activities, driftwood collecting was the most important, because Iceland did not have forests with trees big enough for the construction of houses, boats, etc. The Kirkjusandur-concavity was rich in this resource, and the collecting rights here were most often

owned by the churches in the area. Sometimes the right to this resource was shared by land owners.[34] These owners came here with boats to collect and work the wood. The driftwood came from Norway and Siberia, in today's USSR, but organized lumber-industries in these countries have reduced the amount of wood that drifts away from their shores.

At the end of the 19th century the Th. Thorsteinsson fish-processing plant was established here and sun-drying persisted into the 1930's. Fig. 97 shows the area at that time.

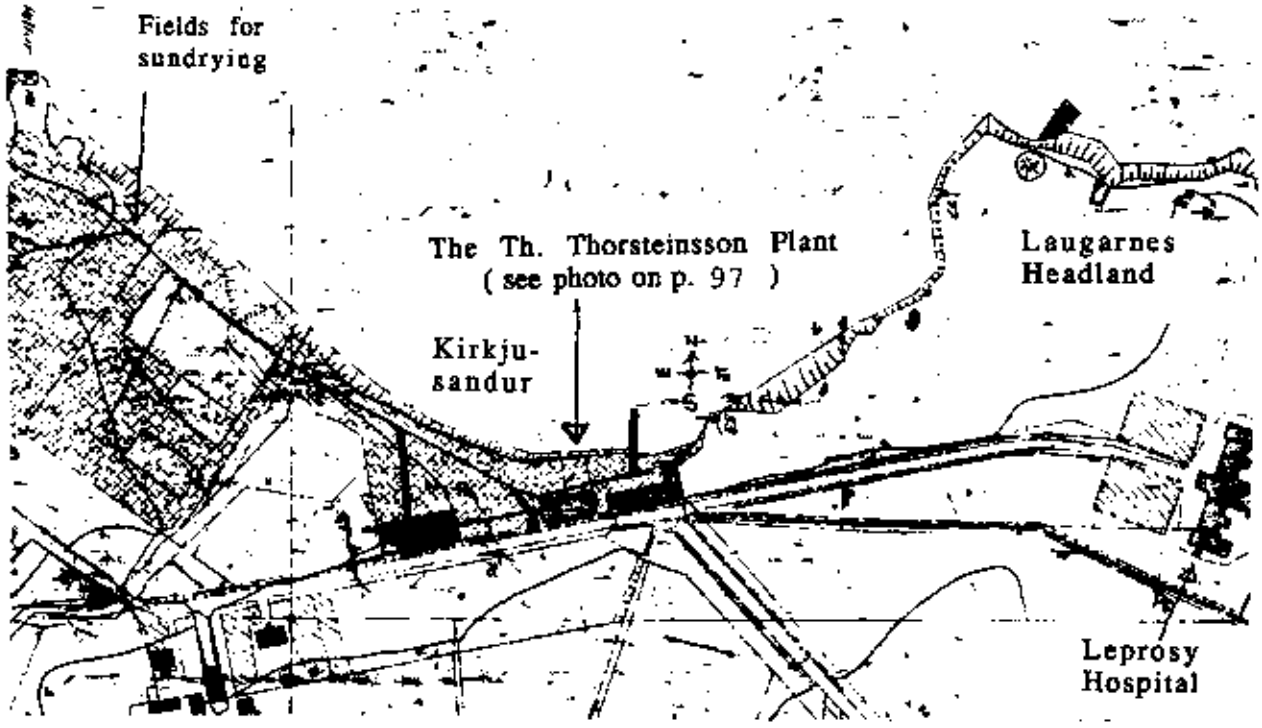


Fig. 97 Kirkjusandur-area in the 1930's

The Laugarnes-headland NE of Kirkusandur has a significant history[35]. Laugarnes is mentioned as a farm in Iceland's most famous saga, the Njall-Saga. A church is first mentioned here around 1200 and Laugarnes was the seat of the

Bishop of Iceland from 1825 to 1850. In 1898 a large leprosy hospital was built, but in 1940 when the British occupied Iceland they moved the last patients away and established a military base on Langarnes as they did on other prominent headlands and hills in Reykjavik and its vicinity. The Danes did this also on convexities at harbors, as for example at Batteri fortress to the east of the Old Harbor. Today the museum of the late sculptor Olafsson is located on Laugarnes, enjoying the fine views that a prominent headland-convexity can provide.

According to the latest land-use proposals (1986) this area is planned to be the only segment of the North Coast that will be preserved as open space; i.e. only some 400 to 500m of a coastline out of almost 10 km. This means that 9.5 km of the original coastline has, or will be destroyed.

In 1703 three farms were located in Laugarnes. Two of them are shown together with their boat-concavities in Fig. 98.

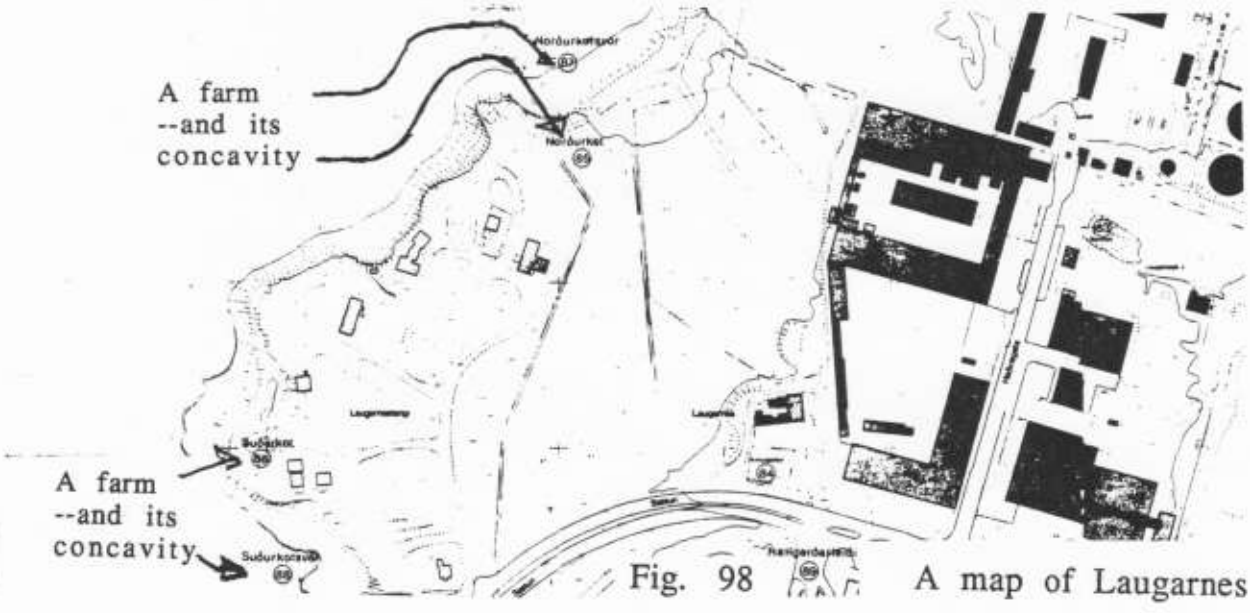


Fig. 98 A map of Laugarnes

As with all other coastal farms in Reykjavik, they depended very much on the resources of the coast and the sea for their survival. The farmer/fisherman who lived in Nordurkot went fishing from Nordurkotsvor into the 1930's. Sudurkotsvor (a concavity at the bottom of the map) was also used into this century but has now been filled up.

Measured from the first map shown in this section (Fig. 96), the HA2 coastline was originally 2.4 km long but is today 2.0 km; a loss of about 400 m of interface in this area. Because of the steepness of the coast the concavities are not much used by today's boat owners (car access is necessary today), but the convexities are still popular because of the vistas they provide to the water-areas. Activities linked to the conv./conc. thus still assist the land/water interrelation.

Case 3: Sundahofn-Harbor (HA3)

As fig. 99 shows the macro-level concavity of Sundahofn has been increased by the building of a convex landfill to its N-West. The prominent SE-convexity has remained much the same.

Fig. 99

The conv./conc. at middle- and micro-levels has been lost within the landfill-area of the harbor (marked with the heavy line). The area furthest N-West used to have large headland rocks that were blown up to get material for the landfills needed for the new harbor. Fig. 100 shows how the largest of these rocks, Kollunarklettur, looked.

Fig. 100
Kollunarklettur (Calling-rock)

Before the ship-sea-harbor a sea-plane-harbor existed in this area. This harbor was established because of Group-flight of the Italian Balboa in 1933[36] .

The first pier to be occupied was Korngardur-pier (with a Corn-silo, see Fig. 101) followed by Sundabakki-pier in 1968--a total of 360m--which in 1984 had been expanded to 630 m.[37] Before Kleppsbakki-pier was built in the 70's traditional small-boats used the concavity as a haven. (K. Andresson and others).

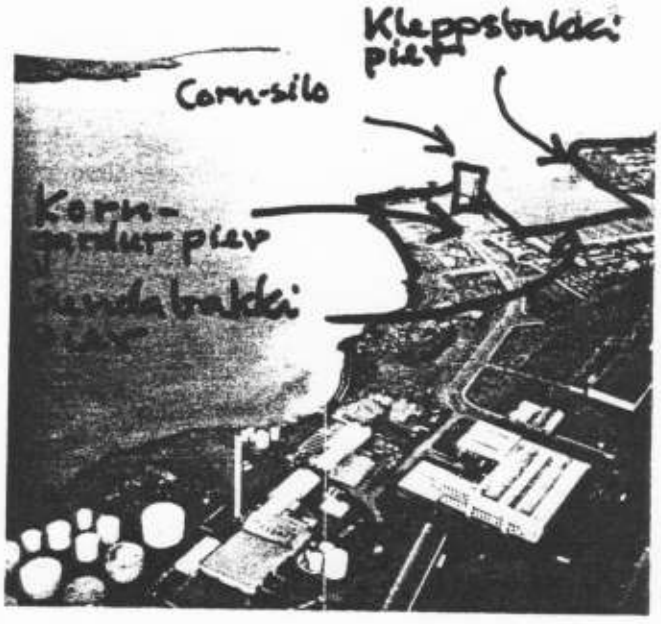


Fig. 101
An aerial view of Sundahofn (1984)

The coastline at the Kleppur green-area is still largely intact but recently (1986) proposals have been made for harbor landfills beyond the coastline. In spite of this, as landscape architect R. Vilhjalmsson has pointed out,[38] this last open spot on the Videy-sound will always be an important place to view the sound and the islands because of its high altitude (up to 20m). Today a mental hospital, workshops and houses for its staff are located in this area. This has somewhat restrained public use, but the location of this institution here has probably helped preserve the area as open space.

Comparison of the earlier coastline with today's (Fig. 99), shows that it has increased in length from 1.9km to 2.1km which is a gain of some 200m due to the increased concavity of the Sundahofn Harbor.

Case 4: Skulagata-Hofdi Area (CA1)

The macrolevel concavity Raudararvik has been somewhat reduced by landfills reducing at the same time the convexity of the Hofdi-headland (Fig. 102). The concavity to the west is so large that it has been little affected by the reduction of the concavity.

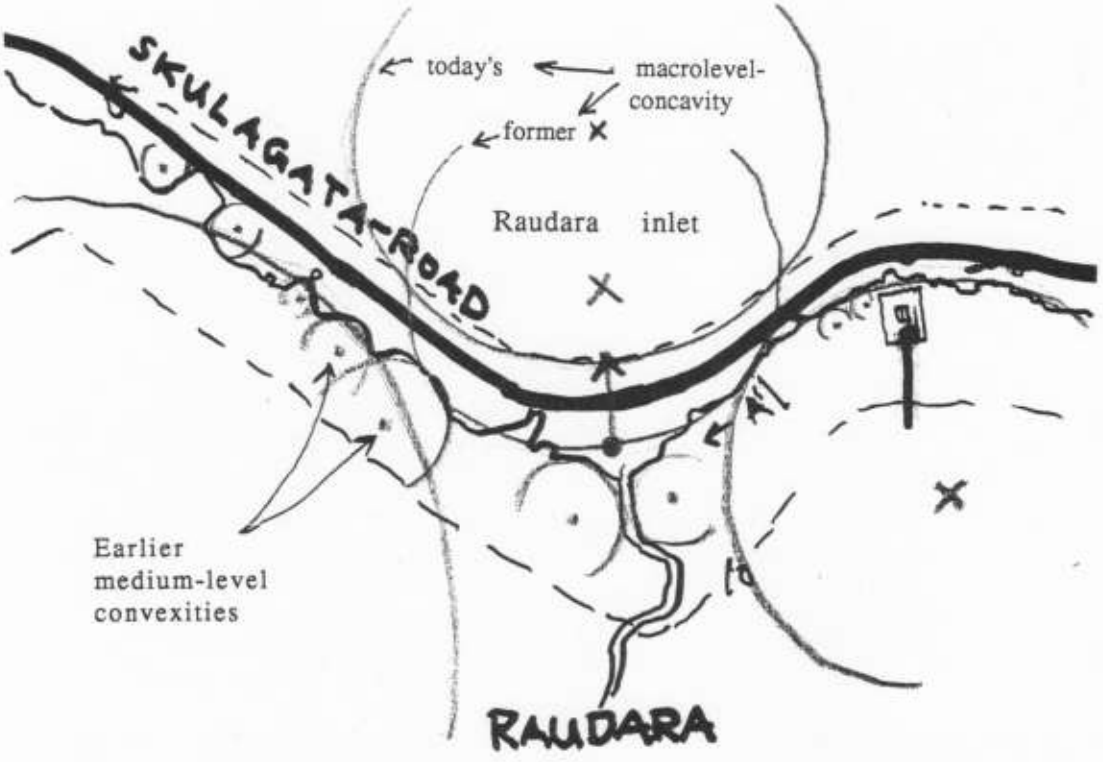


Fig. 102

All of the former coast has now been obliterated with landfills so that today none of the rich convexities and concavities exist anymore, neither at middle-level nor micro-level.

The rich concavities earlier provided fine landing places

for boats on this coast as the following photo from Klapparvor shows.

Fig. 103 Klapparvor-concavity (~1900)

Fig. 104 provides an overview of the number of boats in these concavities. The source is Th. Thordarson's report on the late 19th century.

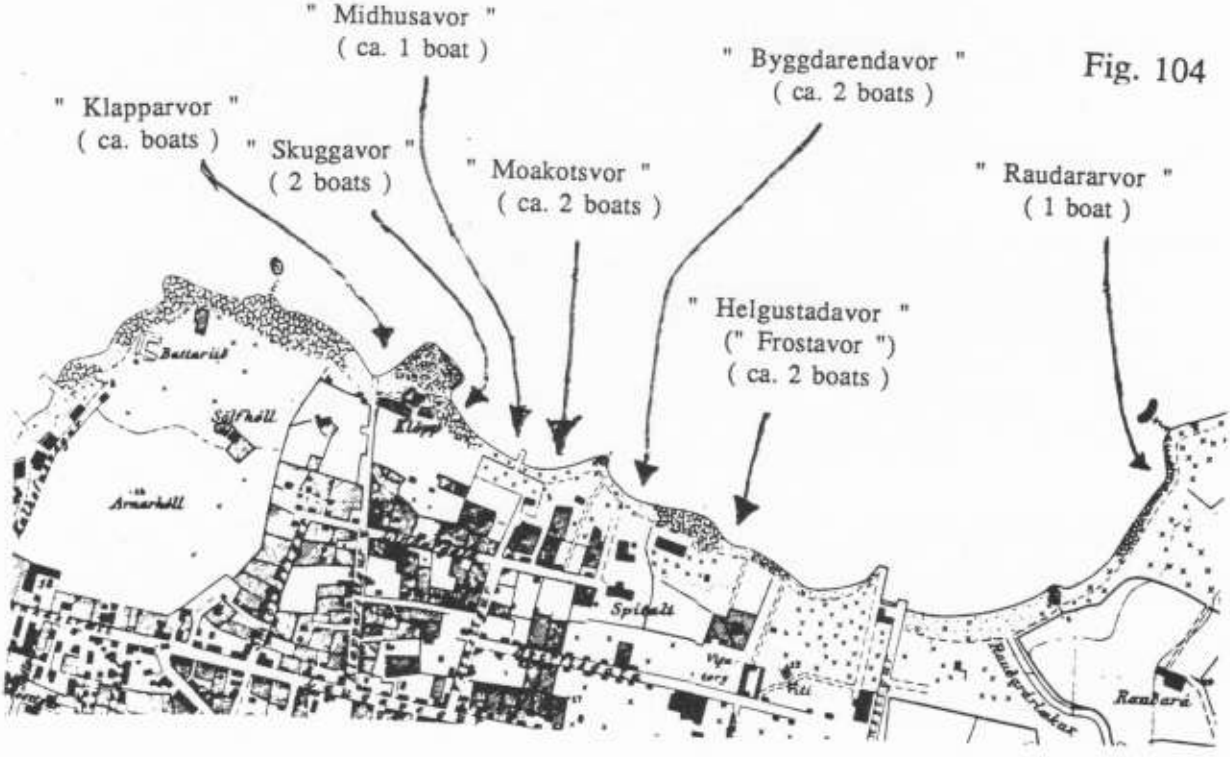


Fig. 104

How various types of occupational and play activities were linked to the concavities of these landing places has already been discussed in the section on The Old Harbor area. When the first factories and fish-plants were built, at the turn of the century, some of them had their own piers going out in the ocean (see the map).

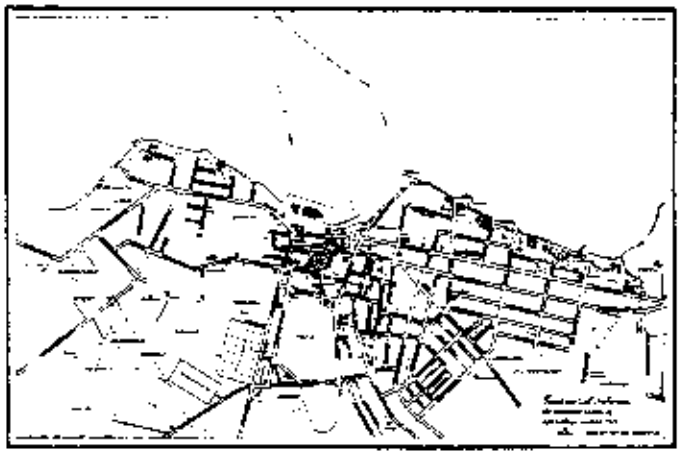


Fig. 105
Reykjavik in 1920

The companies included Sjavarborg, Edinborg (export, import), Kveldulfur (fish-plant), Volundur (lumber import), Slaturfelag Sudurlands (a slaughterhouse), Baronsfjos (a large cow stall), Idunn (cloth factory) and the Gas-production-station. The Hofdi-house, farthest to the east in the area, was built by the French Consul. It had a private pier. The French did a lot of fishing in Iceland waters and a hospital for their fishermen was built in the middle of Skuggahverfi.

A comprehensive historical thesis has been written on the life of the boys in Skuggahverfi in the second decade of the 20th century by M. Hauksson (1986).[39] The following quotations from this thesis, gives an insight into how, and

to what degree, their activities were connected to the shore:

> The beach and the piers were an enormously popular playground (p.177). ...The division of the beach between groups of boys [created sub-areas, and]...the concavities where the fishermen were landing belonged to these sub-areas... (p.178).

No contact of any kind is possible with the beach today due to a large highway which is under construction on landfill (See Fig. 106).

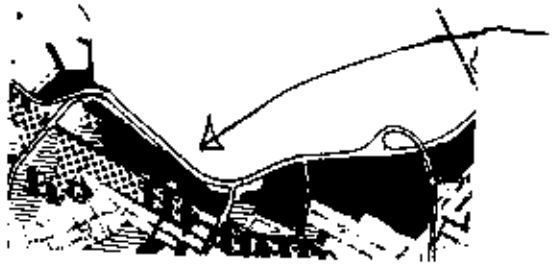


Fig. 106
Highway on Skuggahverfi-coast
(Master-plan 1982)

The highway cuts off all the roads that used to lead to the shore and no landfills are planned beyond the highway. Due to the loss of the richness in curvature of the coast, the coastline here has become 700m shorter in this century. The coastline was 2.0km in 1903 but is 1.3km today (1986). (measured from Fig. 102)

Case 5: Skarfaklettur Area (CA 2)

This case-study-area takes its name from two large rocks in the ocean; Skarfaklettur and Small Skarfaklettur. This area is one single convexity on the macrolevel (Fig. 107) (This is the same convexity as the one to the NE of HA 2). Earlier this whole area was called Laugarnes. Most of this coastline

is close to its original form today, although its land-use consists largely of an industrial area and an oil storage station.

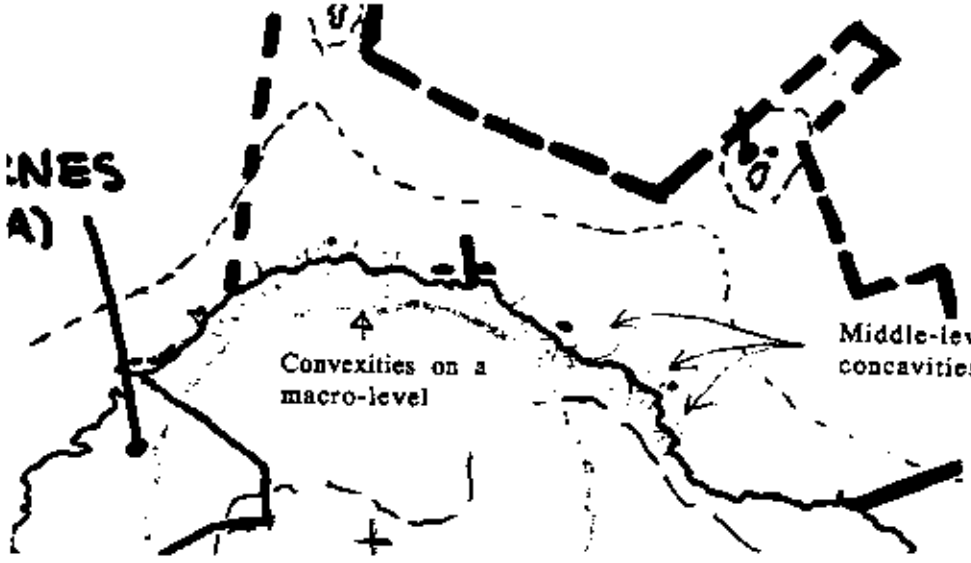


Fig. 107

Because of its steepness and openness to waves this shoreline has not been used much for boats. Before industries were built here the area was famous for its beauty with vivid topography and a view to the sound and the islands. The hills--Studentsholar--to the east in this area, take their name from its popularity with students from old Reykjavik. These same hills were also often called Astarholar (Love-hills) by the people in the neighbourhood.[40]

Huge landfills are planned here which, if carried out, will create a large harbor-concavity (see Fig. 107).

Case 6: Gelgjutangi-Area (CA 3)

As can be seen from Fig. 108, the concavities and convexities on macro-scale are insignificant in this area. They are also rather insignificant on the middle-level, with

the Gelgjutangi-concavity as an exception.

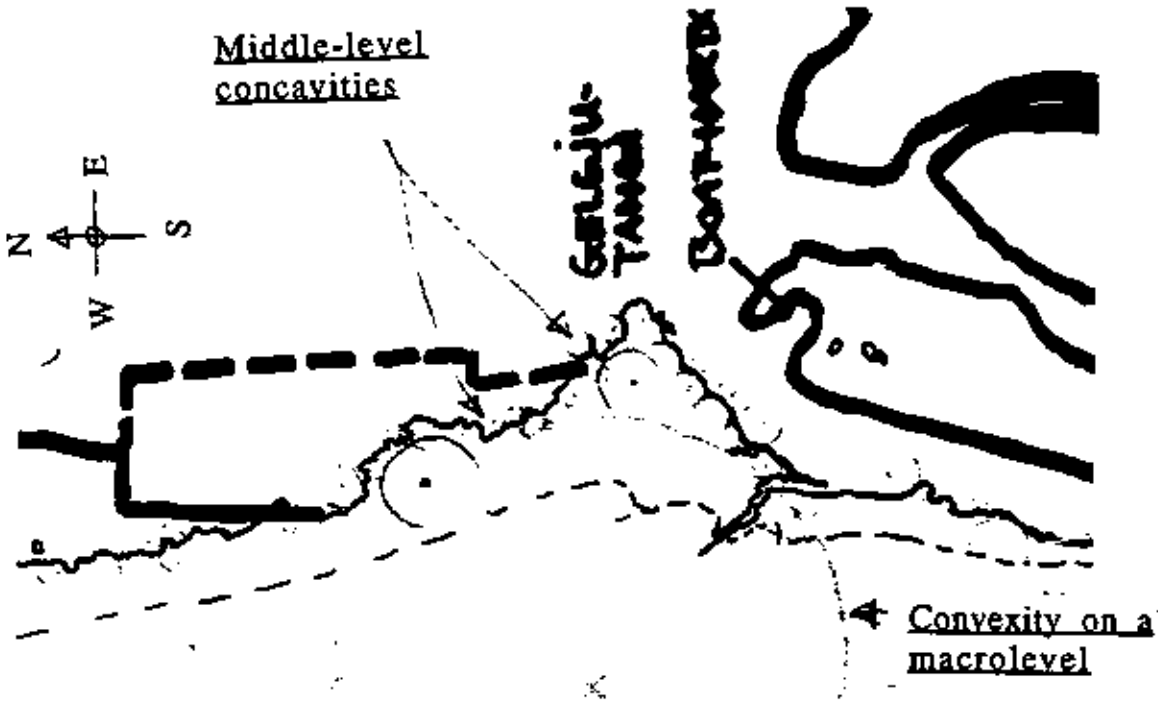


Fig. 108

Human activities on this coast are also insignificant with the exception of Gelgjutangi, where small wharfs have been located for a few decades (Keilir, Landsmidjan). In this area the sea is calm and also shallow which led to the convexity, reaching out to deeper waters, being chosen for the wharfs rather than a concavity as in other cases.

About ten years ago a landfill was made in the northern part of the study area for the Shipping Department of the Co-op union (SIS). This is now a landing place of some 80m length (Holtabakki). An extension is planned. The Union has a large supermarket, Mikligardur, here on a temporary

permit.[41] In the middle section of the study area a few industrial companies with little coast-relations are now located.

The southernmost section of the coast is called Haubakkar (High-banks). This is the only part of the northern coastline of Reykjavik that is especially protected by law as natural-feature (natturuvaetti). Its protection is defined as follows in the Innnes-report:[42]

> An opening of the earth that with petrified shells, seeds and micro-organisms from the second last warmth period of iceage. (p. 78)

Some educational activities are linked to this coastal area but the negative aspect is that the industrial companies have no connection to the shore and the boating harbors on the landfill has limited connection to the urban area (see Fig. 109).

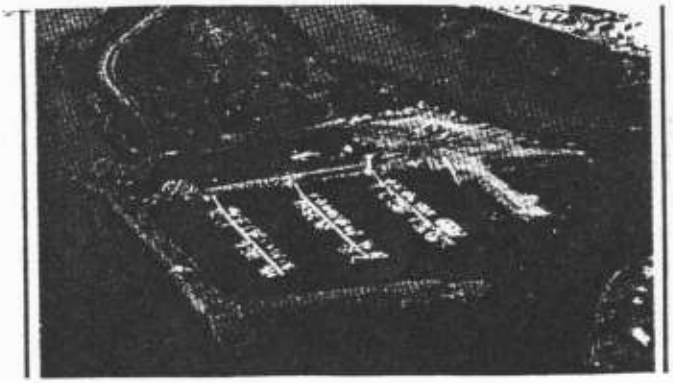


Fig. 109 Boatharbor at Haubakkar

Part of the biological diversity in fjords and concavities is due to variation in the salt-content, caused by inflow of fresh water into the seawater. This results in different ecosystems within the intertidal zones. Fig. 110 shows the differing salt contents in the ocean of the Videy-sounds.

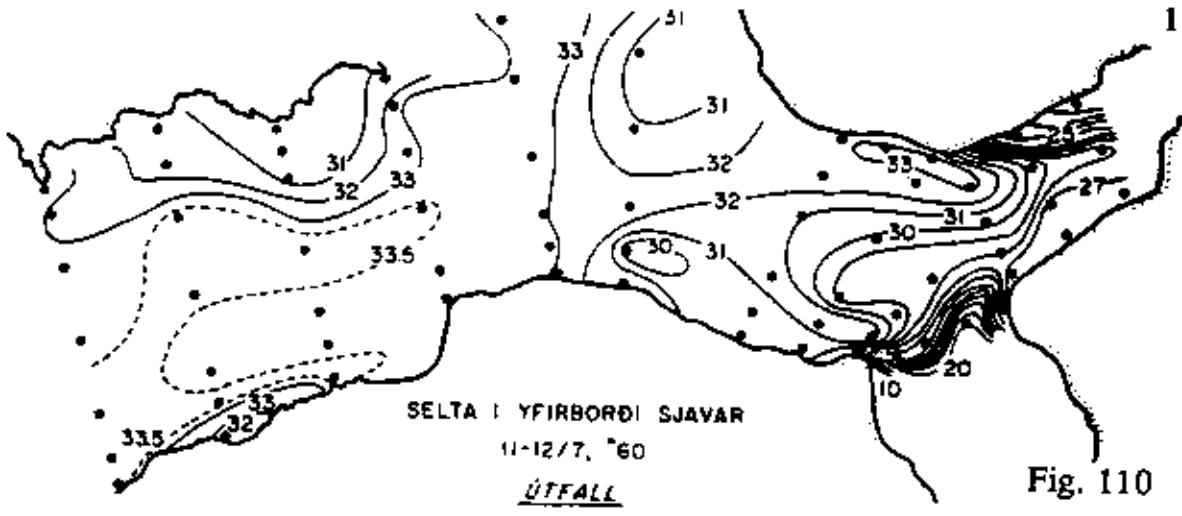


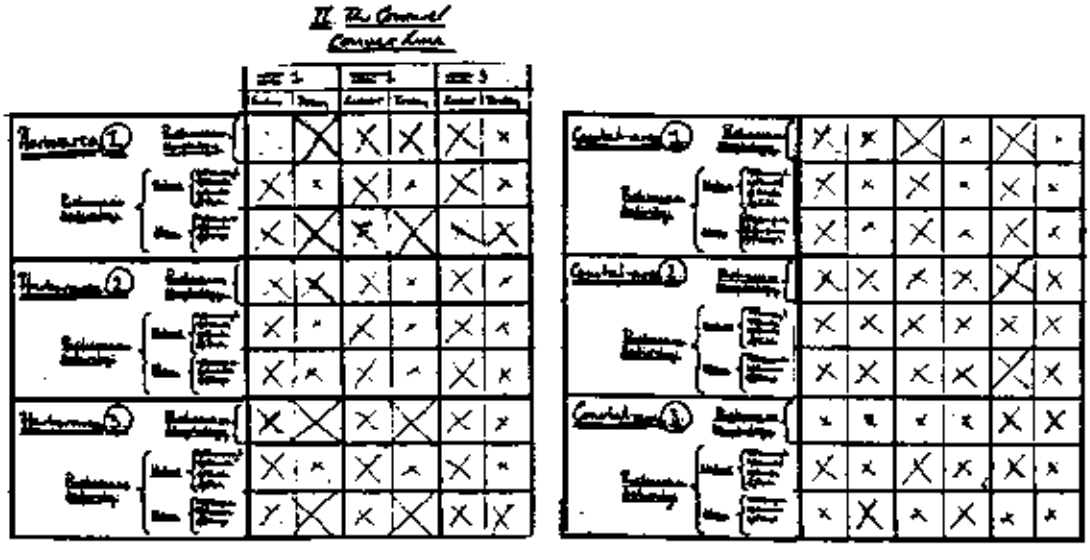
Fig. 110

Biological diversity gets lost, however, if the intertidal zones are covered with landfill. This is what has happened in the Ellidavogur estuary. Coastal ecologist A. Gardarsson says on this in the Innnes-Report (1985):

> One of the most tragic indicents in this country is what has happened to the beaches of Ellidavogur Bay. Their very rich beaches were the foundation for rich bird life. The beaches have now been covered by landfills. (p. 91)

Landfills in unicoastal areas have reduced the original coastline from 2.4km to 2.2km, a reduction of 200m.

The findings of this chapter are summed up in a comparative matrix (Fig. 111).



This forms the background for the grouping of the six case-study areas into the cells of the following diagram.

		Convexity / Concavity	
		more present	less present
Richness in activity	much	HA1 HA3	
	little		HA2 CA1 CA2 CA3

Fig. 112

This result answers Question II positively; yes, a link exists between richness in concavity/convexity and richness in activity in the same areas of their activities help to integrate the land- and water-areas.

CHAPTER 8: Principle III: Complementary features.

This chapter answers this question:

Does increased leisure- and work-related activities occur between an urban- and a water-area in cases where the functions of the water- and urban-areas are a complementary pair?

This question is answered in four steps for each of the six case-study-areas separately.

Step1: What is the functional character of the urban half of the land/water circle? Does it have a water-related character?

Step 2: What is the functional character of the water half of the land/water circle? Does it have a character that relates it to a land-area?

Step 3: Do the characters of the two halves (as defined in step 1 and 2) form a complementary pair?

Step 4: Does a functional interrelationship (in terms of activities) exist between the urban-area and water-area at the given location?

At the end of the chapter the degree to which the answer to the sub questions are judged to be positive or negative is tabulated in a relative and comparative system. In the upcoming discussion the four steps are sometimes linked, and sometimes historical reference is made to the character of these areas, as they are today, clearer through a comparison to earlier periods.

Case 1: The Old Harbor (HA1)

This area has a history of more than 11 centuries[43] so, not surprisingly, the character of the urban- and the water-area and the relationship between the two are multi-layered.

An overview of the main periods follows:

1. The initial settlement (874): The agricultural- and fishing-functions were complementary in the life of Ingolfur. Gradually a degree of specialization developed; people on parcelled-off "farms" were doing more of the fishing--trading fish for agricultural products of the farms in the area. This reduced the complementarity of land and water functions in the lives of individuals but the complementarity of agricultural- and fishing-functions remained for the area as seen as whole.

2. The industrial village (1752): The intention of Country Treasurer Magnusson who conceived the industrial village was to maintain the complementarity of agricultural- and fishing-functions. Vegetable lots were planned and he also bought two fishing smacks. However their operation was faulty and the fishing industry soon came to a halt. It took over 100 years to make a successful second attempt (1866). This failure to let urban- and water-resources complement each other may well have caused the land-based industrial operations (wool mill, etc.) to fail as well.

Fig. 113 Reykjavik in 1801

3. A small fishing village with open boats. (From the early to the late 19th century). As the industrial operations had failed, the population -- which now had increased in number -- had mainly to turn to the sea for livelihood and employment. (Most of the larger agricultural areas were occupied.)

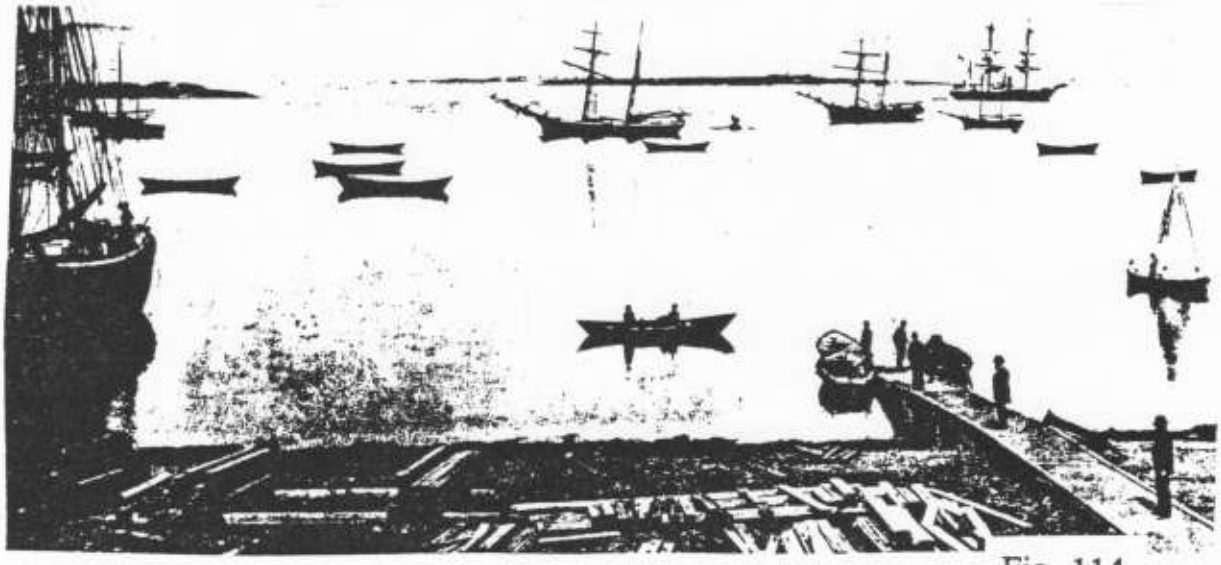


Fig. 114

4. The advent of the smacks (1866) meant that fishing could be an all-year activity, which meant that a real fishing industry could start to develop. Around 1900 the number of

smacks had grown to about 100 and the number of inhabitants to 5800. In 1905 the first steam trawler arrived and by 1915 the number of inhabitants had grown to 14,200.

The character of the town as a fishing town did not change much in this period although the importance of the harbor as a cargo-harbor began to develop in the harbor's east-side. Gradually the fishing-activities were thus moved to the west side of the harbor.

5. In the late '60s a period of fundamental changes began: Part of the cargo-activity was moved to Sundahofn-harbor (1968) and the fishing industry in Reykjavik started to decline due to the Byggdastefna, a national policy established to support primarily the countryside with most of the funds that previously were also used to support fishing-operations in Reykjavik. Also at this time passenger travel to foreign countries by ship essentially came to an end.

Fig. 115

6. Today most of the cargo-activity has moved away from the Old Harbor but some fishing-activity remains in the West-harbor. The future of the east harbor and its warehouses is now an open question. Possible developments include an international fish wholesale-market and a recreational boat facility (Good Mood Harbor).

- - -

As can be seen from this description some uncertainty about the future of the Old Harbor exists and also about the future of the adjacent urban area. Complementary contacts still exist between these two areas, but in answering the question of this chapter, i.e. whether the character of the water-area and the character of the urban-area complement each other, one is confronted with the problem: compared to what?

Compared to the other case-study-areas still much interrelation exists, not least because the interrelation between land/water in these areas has also been on the decline. Compared to earlier periods, on the other hand, a decline has occurred in the interrelation of the old Town Center and its harbor. The decline may be attributed to a number of causes. As the harbor was enclosed and piers for trawlers and cargo-ships were built in 1915, a period started where the harbor activities moved from the other coastline areas into the urban area closest to the newly built harbor. This meant that the lively fish production area around the harbor was gradually taken over by the mechanical functions of trucks and cranes of a large scale fishing and a cargo harbor. At the same time space

for shops and offices expanded in the town-center and took over the housing space. Most of the residents were thus pushed away.

At first (in the '20s and '30s) a considerable amount of this shop- and office-space had a direct link to the harbor; some of the shops were even still located in the same building as the warehousing, e.g. Ellingsen and Geysir, two fishing gear companies.

In the Second World War the British and US armies took over much of the space at the harbor, with the result that harbor-related activities had to be located elsewhere (mostly the fish-processing activities). The ideal would have been that a new fishing-harbor, with enough space around it, would have been built.

The following map shows how the fish-processing facilities, and also some of cargo warehousing, were spread all over town and also to the neighboring communities in the '50s and early '60s. This led to enormous costs for transportation from the Old Harbor to these areas, and also, of course, from the fish-processing areas to the harbor again, once the product was ready for export.

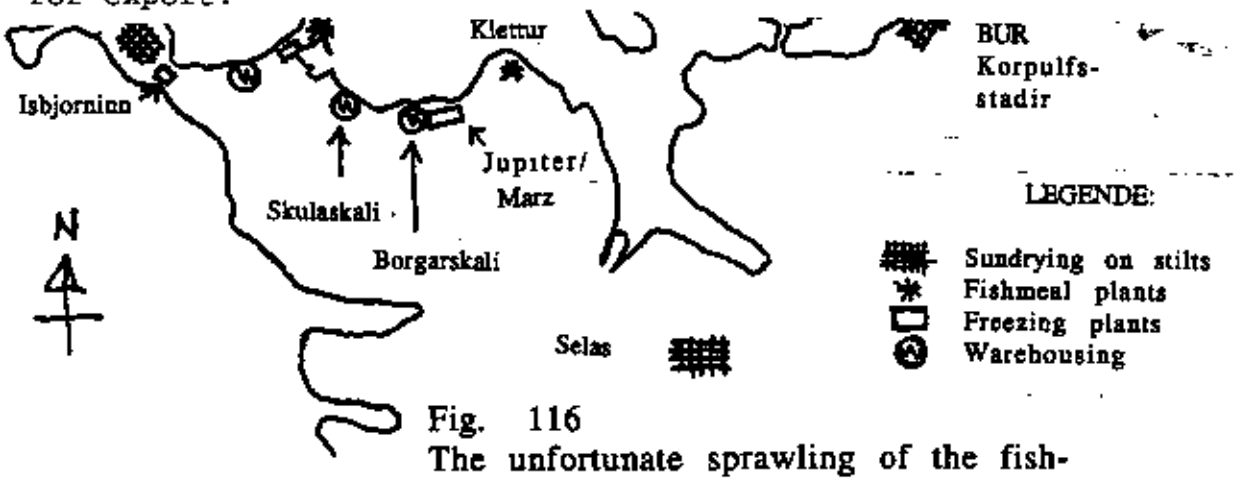


Fig. 116
The unfortunate sprawling of the fish-producing industries in the '50s and early '60s.

Facilities were built at Kirkjusandur (Jupiter & Marz, Klettur, SiS, Borgarskali, Sindri, Hamar) but the proposed harbor unfortunately, from the point of view of the complementary principle, was never built. One could say that more landfills at Orfirisey and the connecting of Engey-island could have provided space for harbor-related activities that was close enough to the Old Harbor, but the primitive technology at this time made it too expensive to realize.

This historical overview has given us some insight into why coherent harbor-units had such a hard time developing in Reykjavik. This historical background is necessary for all the six case-studies. At the Old Harbor new development has started to link some urban activities to the harbor again (housing, fish-restaurant). This development could lead to a new type a complementarity between the Town Center and the harbor.

An overall judgment about the complementary of land and water in this area is, that in view of recent positive developments, and compared to the other case-study-areas, to be discussed, the Old Harbor is still the best area, in terms of complementarity.

Case 2: Kirkjusandur-harbor (HA2)

Formalized land-use plans for this area appear first in the master-plan of 1937. (See the picture).

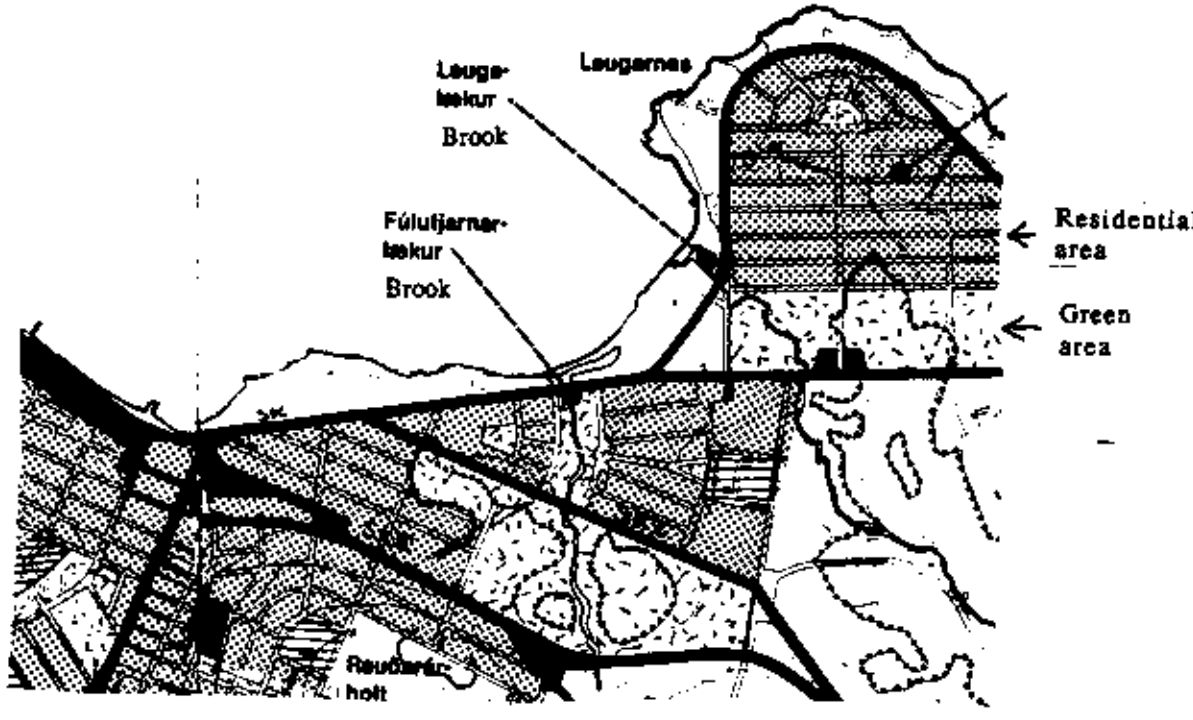


Fig. 117 Kirkjusandur-area in the master-plan '37

All of the land-area in this master plan was devoted to residential areas (grey) with green areas (random dots) in the vicinity of the two brooks. The coastline remained an open question (the old fish-plants were still here at this time). In the master-plan of 1948, however, radically altered land-use ideas appeared (see the picture).

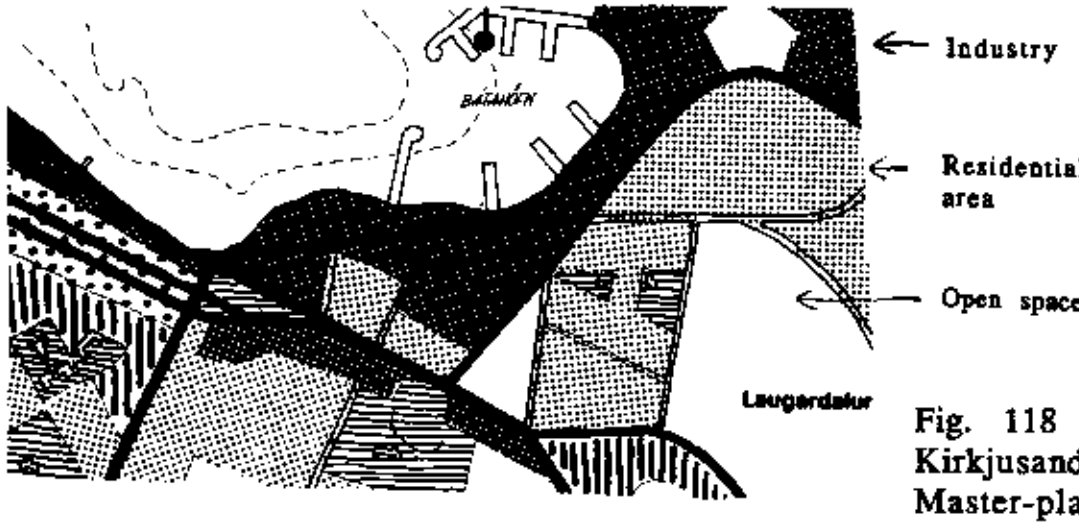


Fig. 118
Kirkjusandur in
Master-plan '48

This map shows the previously mentioned fishing harbor (Ch. 6, case 2) that never got built. The embracing character of the urban area and the rather exclusive fishing-harbor area could have created a tight and complementary unit out of the urban- and water-areas. This was not to happen and later plans reduced the industrial areas by eliminating an industrial area at Laugarnes-headland, proposing open space instead. The main problem with this recreational area is that it is surrounded today by industry with the result that no residential area has a good connection to it. Therefore, the interrelation here between land and water is not as active as it could be. The highway further underlines this separation. (See Fig. 119).

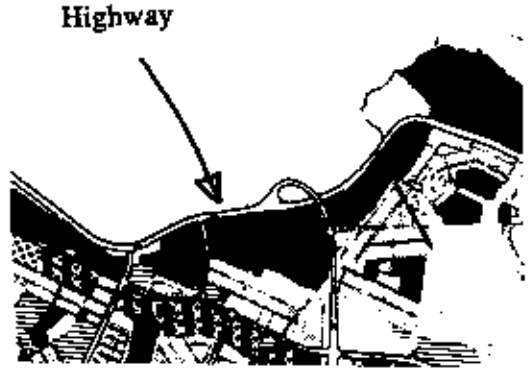


Fig. 119
Kirkjusandur-area in Master-plan '82

The main conclusion of this case-study is that the planning and land-uses adopted in this area have had the effect that urban-activities (e.g. those of the residential areas) have lost direct contact with the water-area. This means that even though the concavity of the coast has a value as a good area for a harbor, a complementarity and interrelation between urban and water exists only to a small degree.

Case 3: Sundahofn-Harbor (HA3).

As described earlier the first segment of this harbor was opened in 1968. The whole land-area (except Kleppur) is planned for industry and warehousing. (see Fig. 121).

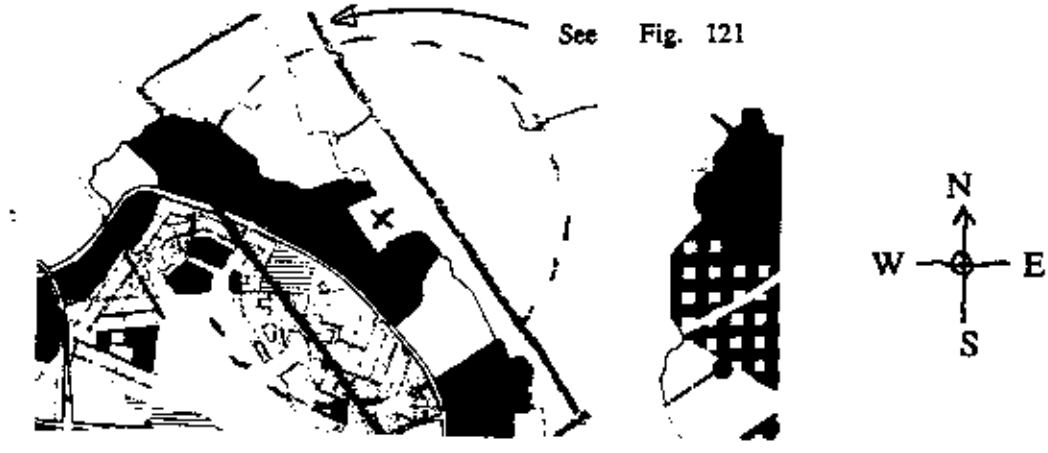


Fig. 120 Sundahofn-harbor area in master-plan 1982

The harbor located here today is primarily a high-tech cargo-harbor (containers etc.). Fig. 121 shows the plan for the harbor-area from 1966[44]

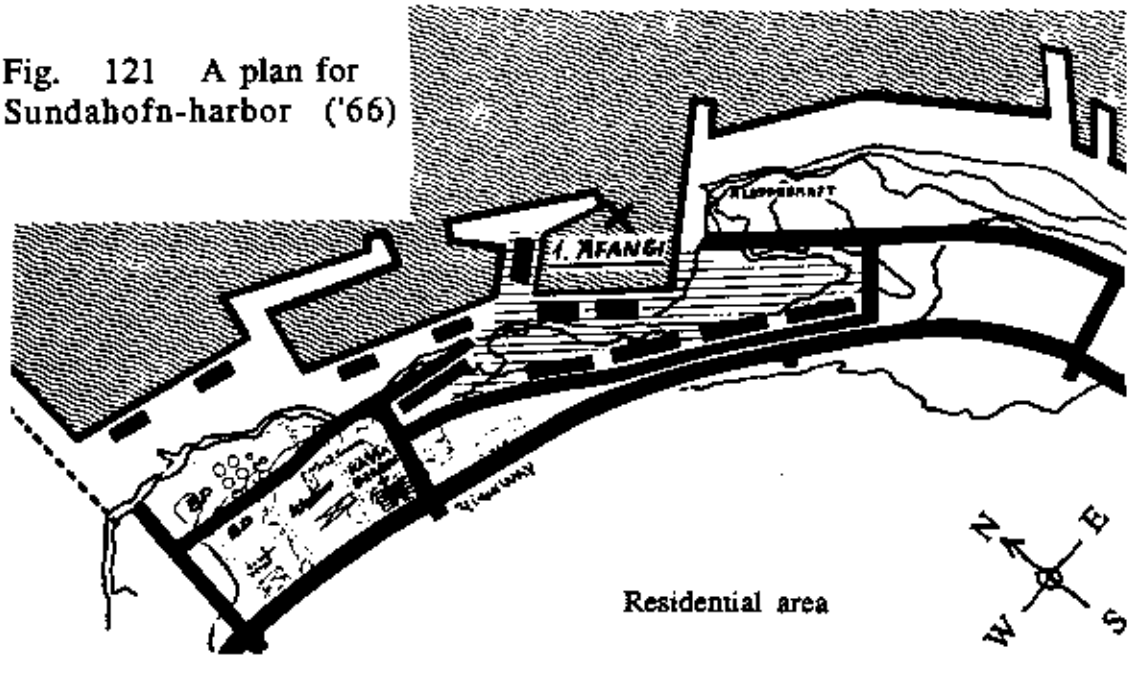


Fig. 121 A plan for Sundahofn-harbor ('66)

The harbor and the land-uses of its upland complement each other and form a coherent unit, but because of the harbor's mechanical nature this strong interrelation does little for the public or residents in neighboring areas, it rather forms a barrier in terms of access to the sea. This separation is underlined by the location of the highway as shown in Fig. 122.

Sundahofn
and adjacent area
(seen from the north-'70)
Fig. 122

Today, the harbor has been closed off for private cars, which is an unpopular measure. This further reduces the

interrelationship between the urban area and the water. Because the harbor is deep enough, foreign cruise-ships can embark here but some of them prefer to anchor in the bay and send their passengers by boats to the Old Harbor. The urban area in Sundahofn is not a complement to cruise-ships. However in the summer sightseeing trips to Videy go from a pier at the corn-silo.

In summary: a complementarity between the cargo-harbor and the warehousing exists, but the closeby residential area is not a match to these functions, and passenger transport for sight seeing in the water-area does not have a complementary match for the industrial area either.

Case 4: Skulagata-Hofdi Area (CA1)

The western part of this area is called the Skuggahverfi-neighbourhood but the eastern half used to belong to the farm Raudara. The first cottage built in Skuggahverfi was Jenskot (Skuggi) in 1803.[45] Development was slow at first; 20 homes by 1850 and the area remained outside Reykjavik's jurisdiction until 1835. At first people were so poor here that they did not own boats themselves. Some of them got occassional jobs from boatowners and merchants. Although looked at with suspicion by their contemporaries in Reykjavik a part of the necessary workforce came from here as Reykjavik started to develop in the late 19th century. A somewhat more affluent neighbourhood Efri-Thingholt was located upon the hill of this coastal area to the south. (See Fig. 123).

Boat ownership meant independence for people in these areas and the number of boats grew from 1/2 boat in 1829 to 10 boats in 1839 and 13 boats in 1847.[46] Because of this the interrelation with the water-area increased. The area closest to the coast was not settled by the cottages because cultivation was difficult there due to salt from the open sea and the rocky terrain (marked with X's in Fig. 123).

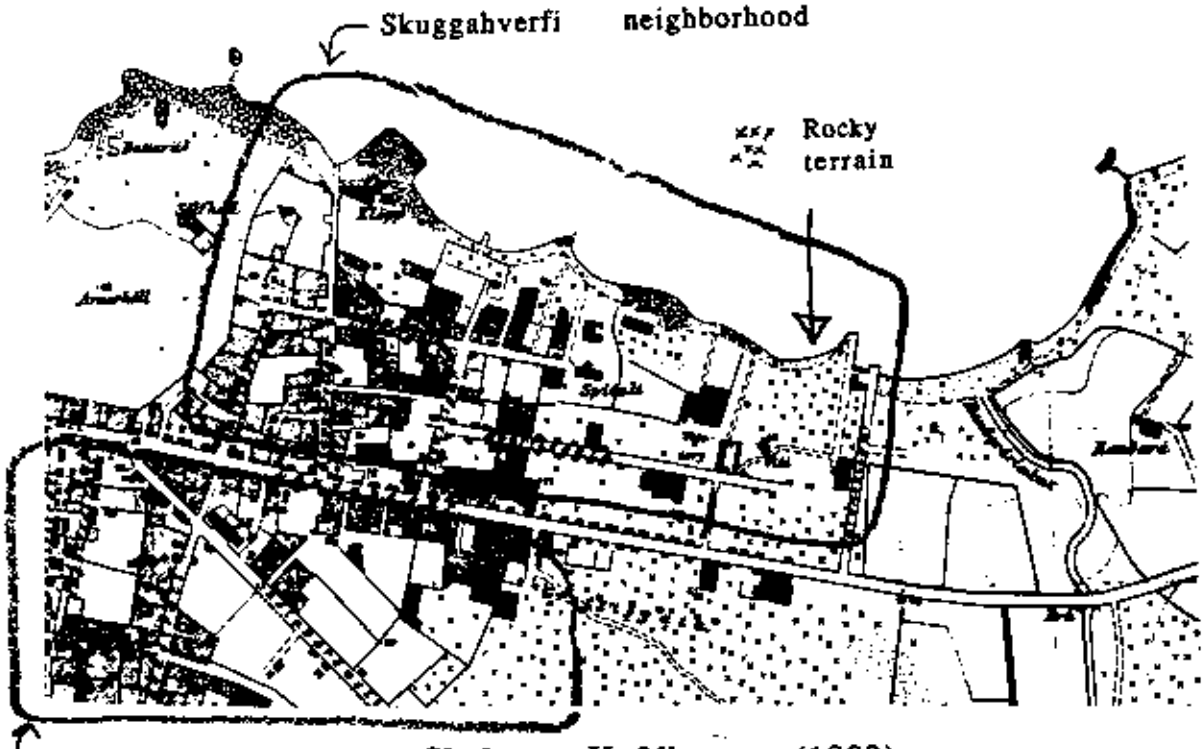


Fig. 123

Around the turn of the century, as companies started to locate on the coast, these rocky areas were useful for the sundrying of the fish (see the photo).

Fig. 124 Sundrying of fish in Skuggahverfi neighborhood

In the master-plan of 1927 a road was planned on landfills in front of the companies and the piers located on the coast. The contact with the water that these landfills cut off, was supposed to be replaced by a railway that connected the companies with the new harbor - as well as to the railway station to the east. (See picture).

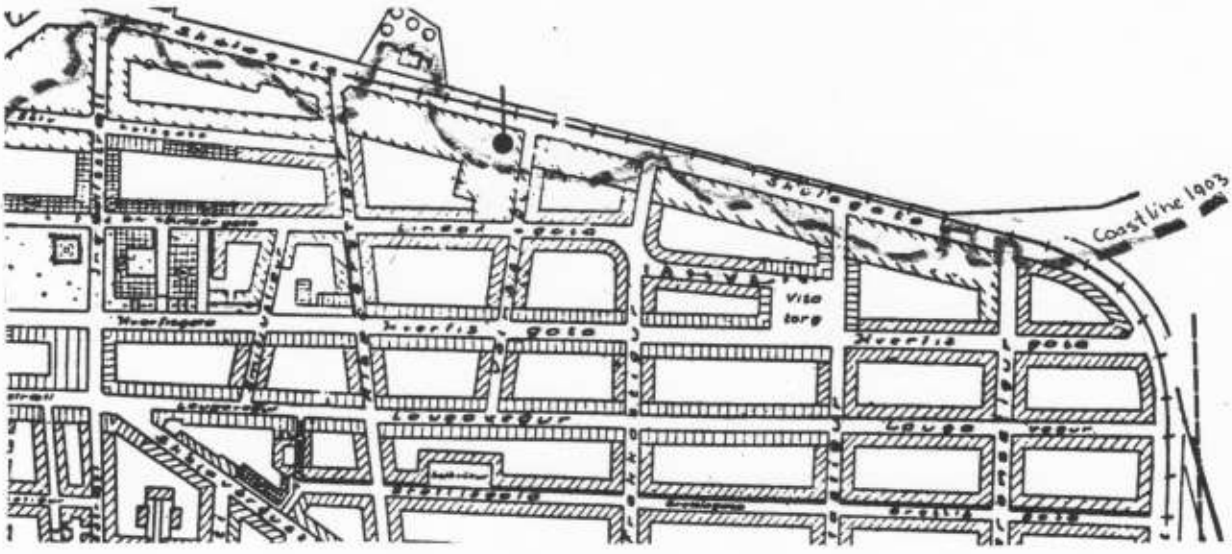


Fig. 125 Skulagata-Hofdi area in the master-plan of '27

The railway was never built but the Skulagata-road on a landfill eliminated the concavities, and also the convexities and the piers that used to be the link that created the neighbourhood's functional relation to the water-area. Gradually the coastal character of the neighbourhood deminished and the boats and ships dissappeared from the coastline. Later master-plans have foreseen industrial uses for most of this coastal zone and many non-harbor or sea related activities are located here today. Harbor-related industries here transport goods by trucks to and from the two other Reykjavik harbors.

Today there are plans to demolish the old industrial-buildings and warehouses and build a residential area (see Figs. 72 and 73). The architecture of the new designs does not have a coastal character and no functional interrelation is provided between these residential units and the coast- and water-area. Possibilities for land and water to complement each other have not been taken advantage of.

Case 5: Skarfaklettur-Area (CA2)

In the master-plan of 1948 the whole North Coast of Reykjavik, except Kleppur, was planned as an industrial area. An open area, was shown around the Laugarnes-farm. However, it disappeared in the 1957 plan. In the 1965 master-plan the Laugarnes coastal-area is shown as an open space again. This area is within area HA2 to the west of our study area. In a master-plan, currently in preparation (1986), this green area is extended to the proposed harbor landfill of our study area (see

the triangle on the map).

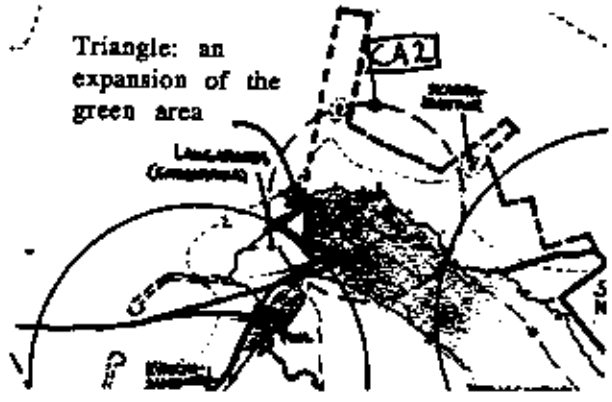


Fig. 126 Skarfaklettur-area

Quite possibly this area has been preserved, from the industrial development, because it was occupied by army barracks in the second World War the bulk of which was not removed until the 60's. Due to environmental awareness and regrets about losing the whole coast to industry, the Laugarnes open-area has been preserved. In the early 50's industries started to settle in the eastern part of this area, the first; a B.P. oil-station. (See the map).

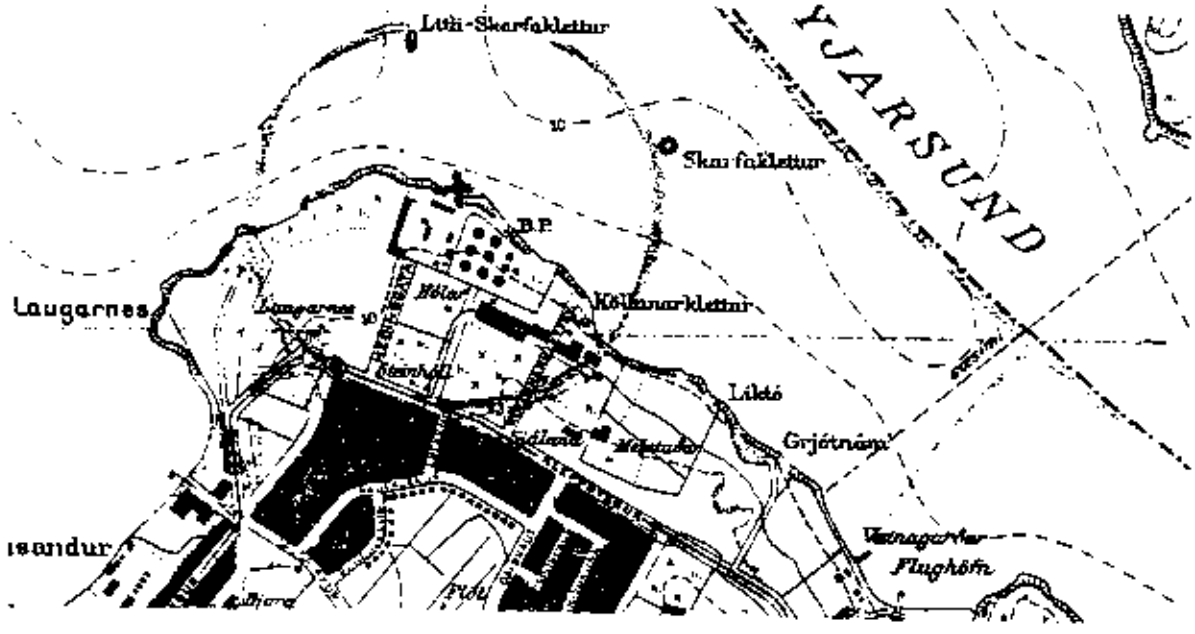


Fig. 127 Skarfaklettur-area in a map from 1956

In a report to the City Planning Office, landscape architect R. Vilhjalmsson underlines the uniqueness of the Laugarnes-area.[47]

> Laugarnes is going to be the only natural coastal area all the way from Haubakkar in Ellidavogur-bay to Orfirisey-island, i.e. the only area on the whole North Coast.
>
> First of all, the untouched coast is valuable. It is quite varied with rocks and headlands going out in the ocean, and it also has sand beaches, finely placed in the landscape. On the ocean birds, and salmon and seals can be seen. A wide view is provided from this headland to both mountains and islands, but also into the city." (p.1)

The following map accompanies Vilhjalmsson's report:

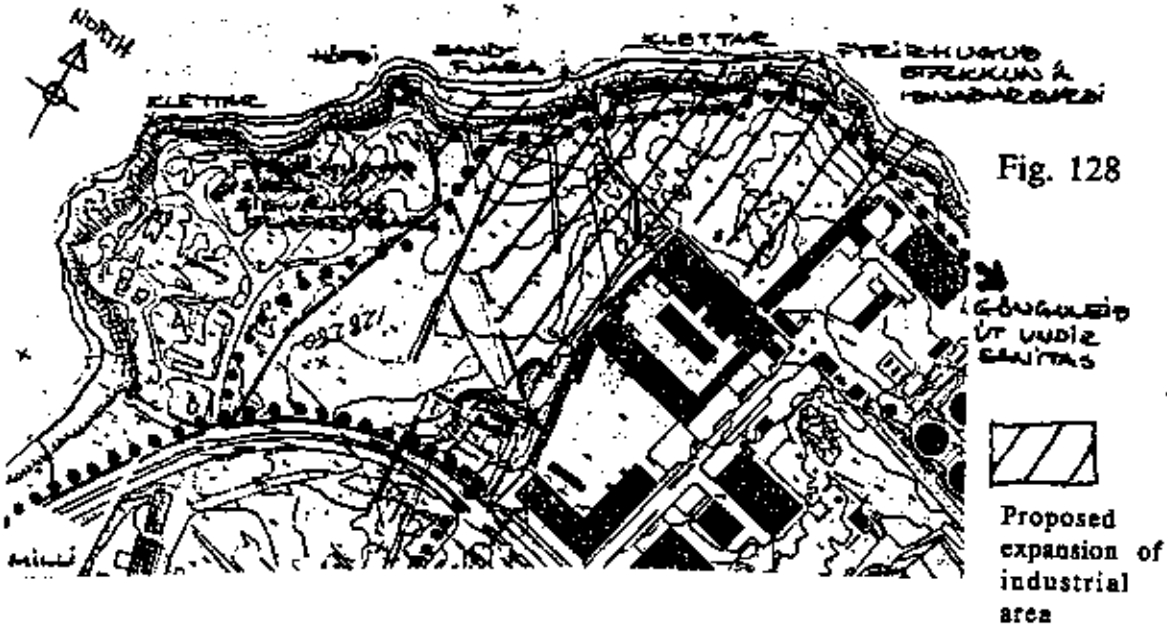


Fig. 128

This natural land-area is a match to the natural water-area; a fine example of the complementarity of natural land- and water-areas. In order that this quality can be preserved the proposed expansion of the industrial area (Fig. 128) would have to be cancelled, and most importantly, the landfill proposal which would submerge the Skarfaklettur-rocks--should not be carried out. The complementarity of land and water that exists

here today is, however, somewhat reduced in its value because close-by residential areas are cut off from this open area by industrial areas and a highway.

Case 6: Gelgjutangi-Area (CA3)

This area, like the previous area, was determined as an industrial area in the master-plans of 1948 and 1957. In the plan of '65 a narrow strip of open land is shown at Haubakkar (which is a steep coast with exposures of ancient geological formations). In the plan of '77 a proposal appears on how to finish off the progressing landfills on the mudflats in the bay. In this plan also, a possible bridge over the bay is shown, an idea that is still kept open in today's plans. (See the '77 master plan).

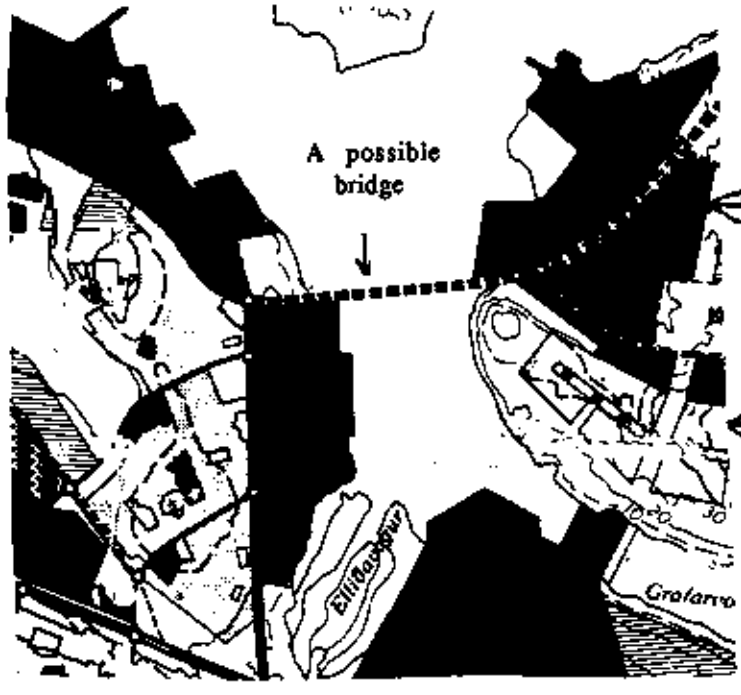


Fig. 129
Gelgjutangi-area in master-plan '77

Today's ideas on harbor landfills are similar to those on this map. The northernmost part of these landfills has been completed. As concerns the question whether a complementary effect and match between land- and water-areas exists here, one has to distinguish between three sub-areas.

The northern-most section is the cargo harbor of the Co-op union. This is a closed harbor, and even though a supermarket is located here, no contact has been created for people to the beautiful water-area (one could, however, easily build a restaurant on the top of the supermarket or the warehouses to provide some degree of a link). The middle section of the area is still an open question and the large wharf planned here may not be built.

The small wharfs on the Gelgjutangi headland are pleasant and here the access from the close-by residential area could be strengthened. Gelgjutangi is a popular area for viewing boats and water, and a restaurant here could enhance that activity. The following map from 1956 shows the disposition of the Gelgjutangi-area as concerns water- and residential-areas (gray).

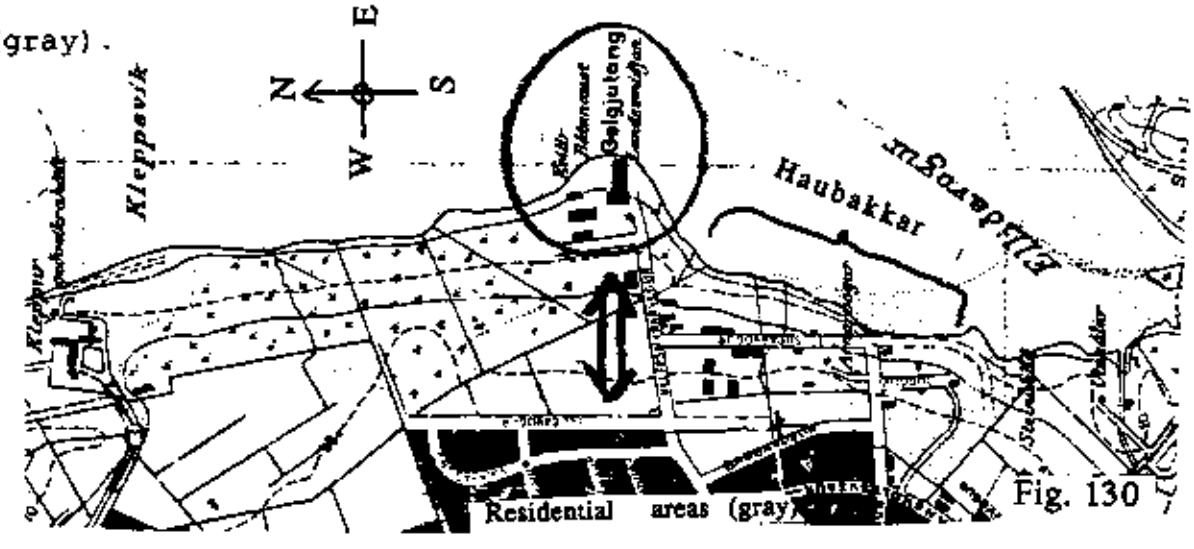


Fig. 130

The southern-most section of the area is the Haubakkar-area with a narrow strip of water adjacent to it, closed off to the east by a landfill. Almost no natural life occurs here in this interface so the complementarity is not active. The industrial area behind the preserved coast- and water-area do not match and no ready access is provided here down to the water. Geologists and students have a hard time reaching the coast because of the industrial area. On the landfill a boating harbor has been built (see the next picture).

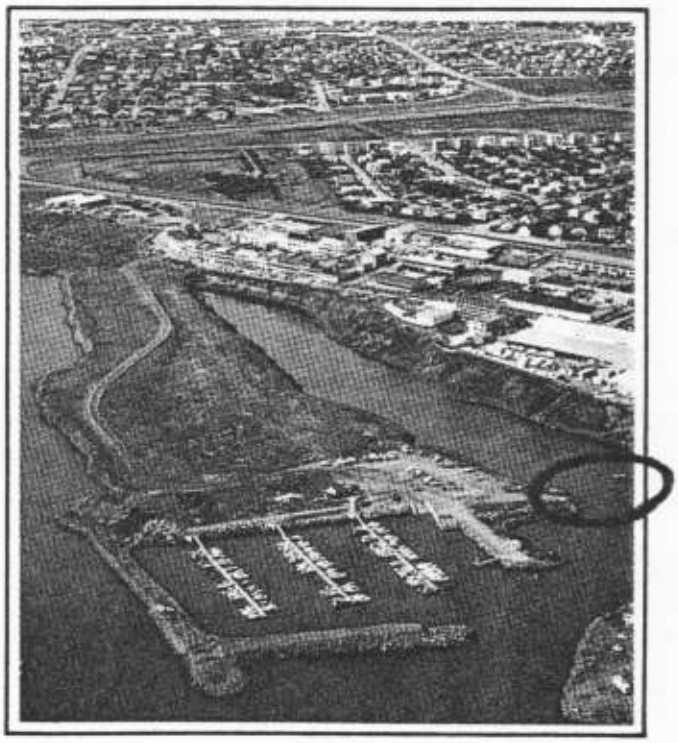


Fig. 131
Boating-harbor

The boat harbor is a complementary match to the water-area which is calm and surrounded with an interresting topography although much spoiled by the industrial facilities located here. The boat harbor landfill has little contact with the mainland

and no contact to the close-by residential areas, that certainly would be a natural match to the outdoor activities located at the harbor. A useful contact could be created with a pedestrian bridge to the area south of Gelgjutangi.

\- - -

The findings of this chapter I sum up in a comparitive way in the upcoming matrix. (The different sizes of the X's indicate differing degrees of relations). The text, however, has only described where the relations are strongest (large X) and where they are weakest (the smallest X).

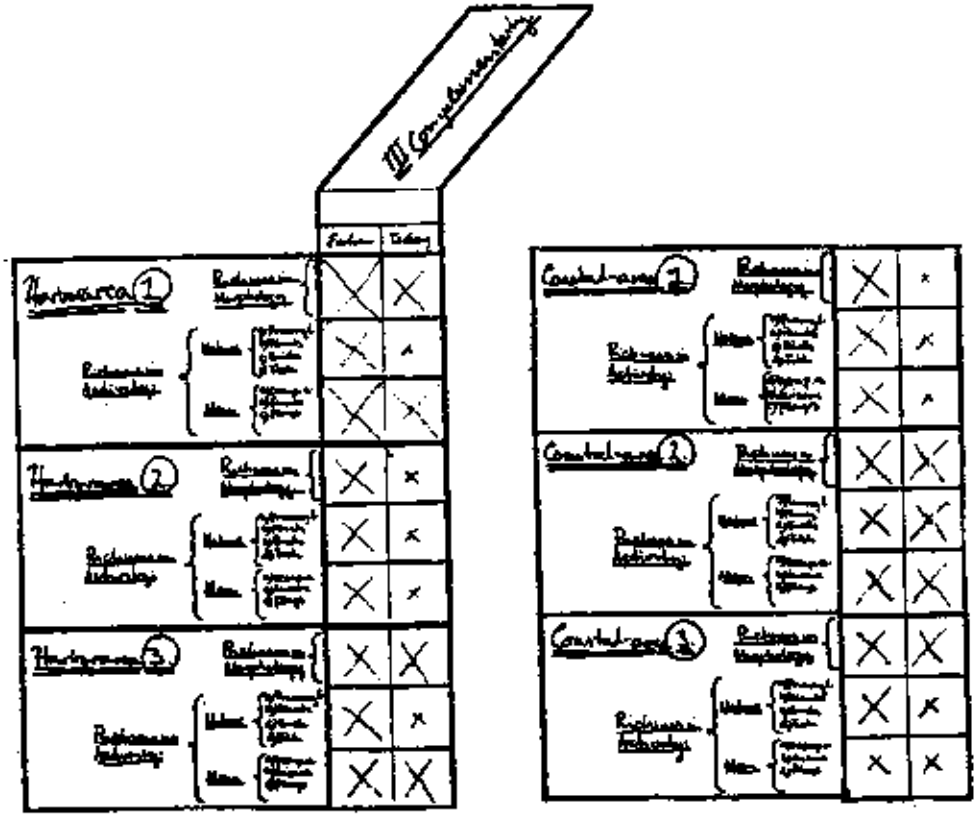


Fig. 132

This forms the background for the grouping of the six cases into the cells of the following diagram.

		A matching relationship in character between adjacent urban and water- areas	
		more present	less present
inter-relation	more strong	HA1 HA3 CA2	
	less strong		HA2 CA1 CA3

Fig. 133

This result answers Question III positively; yes a link exists between richness in the complementary character of land and water, to the richness in the interrelation between the two areas. The findings that the reverse is also true--i.e. that less inter-relation occurs in areas where a matching relationship is less present--also supports my hypothesis.

CHAPTER 9: Principle IV: Cores of the opposite areas

This chapter answers this question:

Can the presence of land-cores in water (islands, etc.) and/or water-cores in land (lakes, etc.) have a positive influence on the interrelation of land- and water-areas?

Each of these two types of cores occurs in three size categories:

Land-cores in water:	Typical length in Reykjavik:
1.Map-level Islands	0.5 to 4.0 km
2.Medium-level Rocks (or islets)	2 to 10 m
3.Human-size-level Small rocks	0.5 to 2 m

Water-cores in land:	Typical length in Reykjavik:
1.Map-level lakes or lagoons	100 to 500 m
2.Medium-level Pools	10 to 50 m
3.Human-size-level Small pools	0.5 to 2 m

Each of these six types of cores may have biological and human activities linked to them. Biological activities breakdown to a) primitive life-forms, b) plants c) birds and d) fish. Human-activities breakdown to; a) occupational activities, b) leisure activities of adults and c) children's

play.

The biological activities of the six types of cores form six different branches of ecology; and we speak of island-ecology, lake-ecology, rock-ecology, etc. Actually this breaks down further according to e.g. whether an islet is in salt- or fresh-water or whether a pool contains rainwater or is salty. This description makes it clear that much diversity in topology (form) results in a corresponding diversity in natural activity, and the diversity of wild life in a given area will be increased accordingly.

Iceland is traditionally a nature-oriented culture and the scarcity of food in older times meant that food-products from these ecologies (plants, birds, fish) were a part of the Icelandic cusine. In earlier times the collecting of eggs, seaweed, dulse, clams, lobsters, etc., and shooting or catching of birds and catching of fish at the coastal areas were seen as occupational activities. Today they are seen as leisure or play activities. A reduction in the number of the cores and a decline of nature-activity associated with the cores, obviously leads to reduced possibilities for man to utilize these resources.

The decline in the number of species of plants and birds in the islands and the decline in down-harvest and lumpfish-catch has already been reported. (See Ch. 7). Additional data will be supplied in the following case-studies. Also, examples will be given of human activities in or around these cores that are not directly related to their ecology.

Each case-study, however, starts by a documentation of whether a decline in the number of cores (within each level of size) has occurred, together with notes on the reduced or increased interrelation of man with these areas, accounting for a corresponding level of interrelation between urban and water-areas.

Case 1: The Old Harbor (HA1)

Fig. 134 shows the earlier (1903) and current coastline.

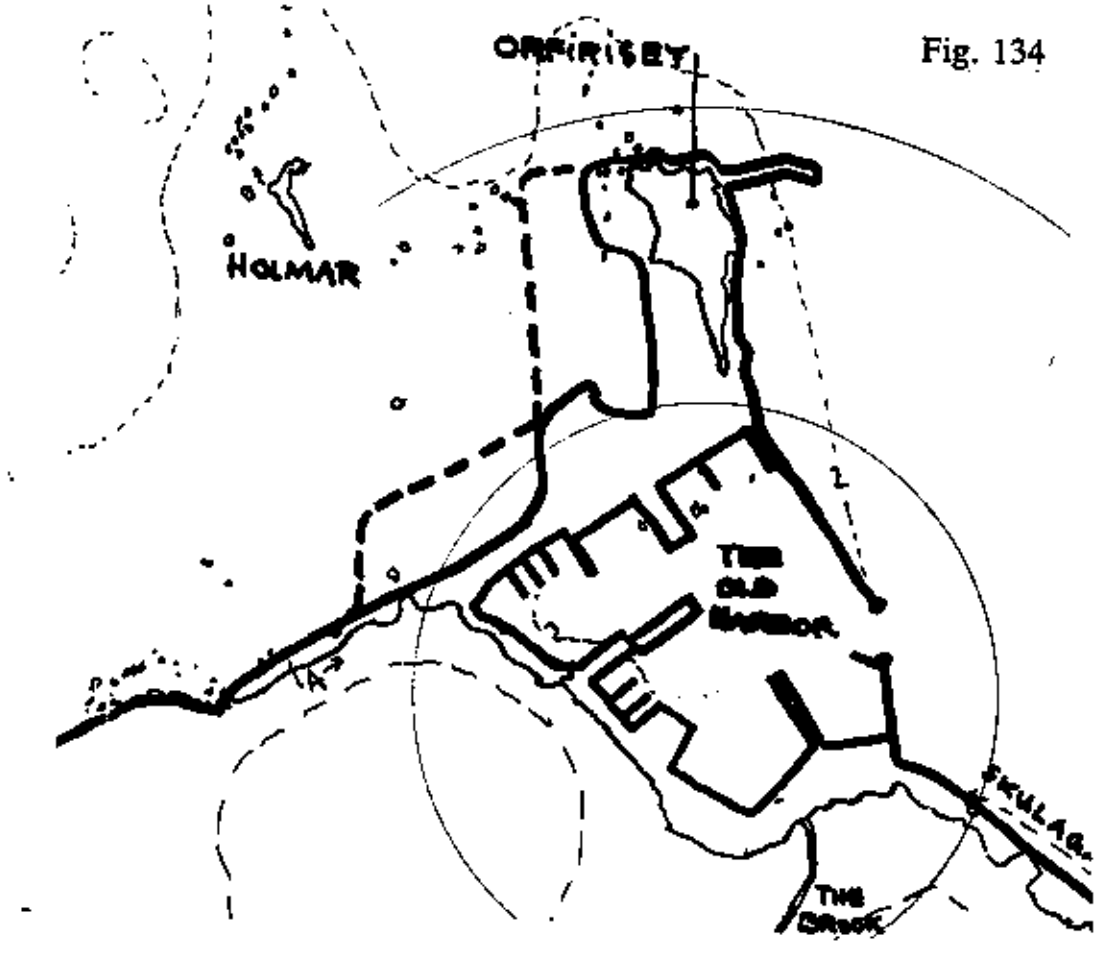


Fig. 134

The map shows that the island quality of Orfirisey-island has been lost because of landfills connecting it with the mainland. The island's utility in earlier ages, as an easily defendable trade port, has been explained. In WWII the occupation army had a fortress on this island. In the 19th century, and well into this one, walks to this island along the causeway, and later the narrow landfill, were popular[48]. Still earlier Holmar- and Akurey-island (further north) could also be reached by foot, during the ebb tide along their causeway. By adding to the height of this causeway such an approachable island-quality for this area could be recreated. The following sailing map shows the depths of the water in this area (in meters).

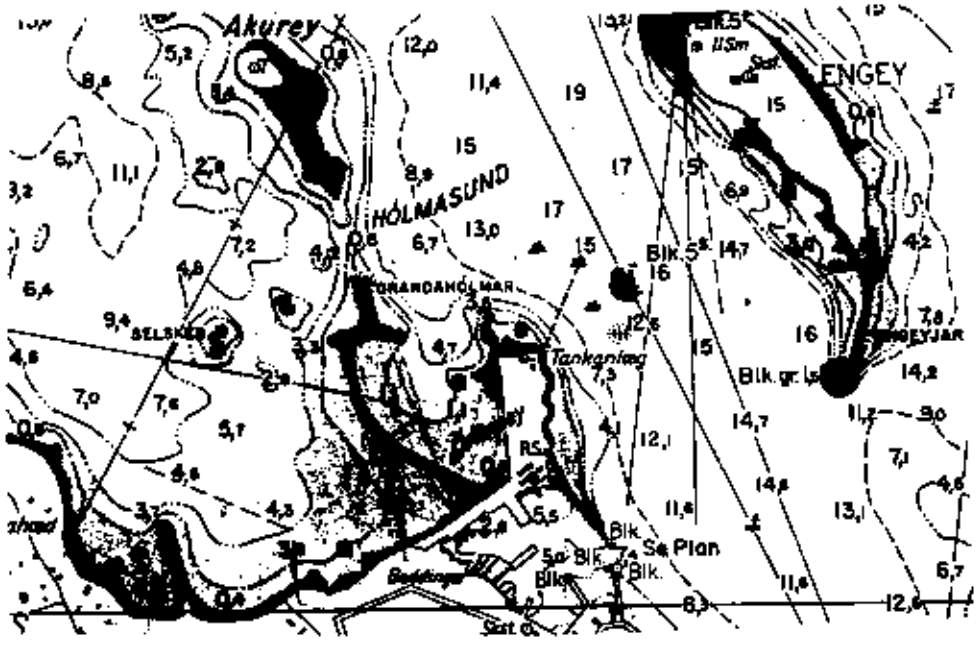


Fig. 135 Depth of the ocean area to the north of the Old Harbor (in meters)

Fig. 134 and 135 show that many land-cores on a medium level used to exist in this area, but a comparison with Fig. 134 shows that many of them have been submerged by landfills (within

the bold line). The human-size cores (rocks) can not be seen on the maps, but they can be seen on the following photo from the west-side of the Old Harbor (i.e. both cores in land and water).

Fig. 136
Pools and rocks in the Old Harbor

Many different kinds of life-forms used to be connected to these cores; algae, clams, star-fish, shrimps, small birds, etc., and areas with such cores were also a popular place for children to play. All such life has vanished from the coastline in this area because landfills have covered every piece of the natural coastline[49].

One water-core exists on map-level in this area; The Lake. The Lake has been made smaller by landfills and the natural shoreline is completely changed. That the Brook, connecting the Lake with the harbor, has been made a closed sewage-channel has many consequenses: Trout and eel no longer can enter the Lake. Natural dredgeing does not take place, so the Lake has become shallow, and has to be machine dredged. The Lake freezes to the bottom in the winter so no fish can live there, because it can not escape to the ocean during periods of extreme cold. Boats

can hardly be operated on this shallow water anymore and no boat-contact with the harbor is possible. In the last century boats used to be located here, and a proposal was made to dig the Brook and the Lake out to make a harbor. Reviewing these facts provides us with a reference-point to judge today's situation.

Sewage and hot water (from the geothermal heating system), which flows into the Lake, reduces the number of days that the ice here in the winter is strong enough to allow skating -- an activity that was very much a part of the down-town atmosphere earlier. In previous periods the Lake was clean enough to use ice taken from it for the ice-houses. Some of this activity connected the Lake to the shore because of transportation of ice to an ice-house at the harbor and of fish to the icehouses at the Lake. The following diagram and photo give an indication about the ice-production industry[50] .

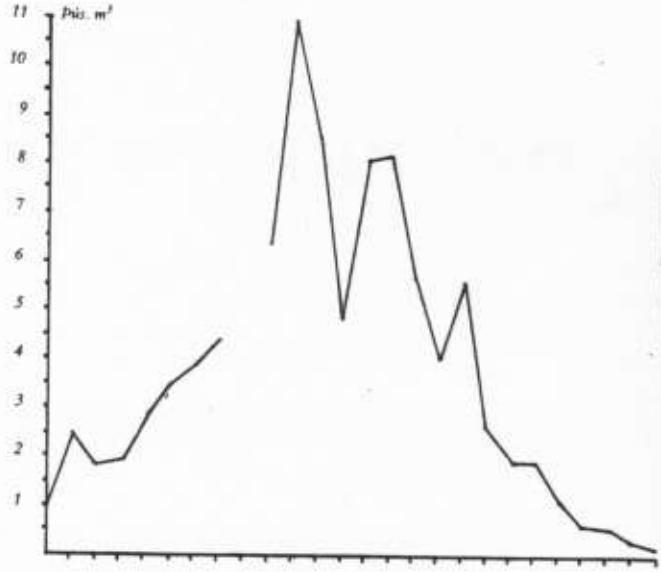


Fig. 137

Fig. 138

Today a population of ducks and swans are the most prominent and popular features on the Lake. The swans, and a number of new duck species, were brought to the area in the 1950s. Cores of land (small islands) have been built in the Lake to provide a refuge for them for nesting. The birds feed mostly on bread given to them by people enjoying the place. A small water-core (a wading pool) was built at the side of the Lake (at Frikirkjuvegur 11) in the 1950s, but this pool has been emptied because of the complaint that children could catch cold wading in it.

This discussion has shown us that a decline, in terms of richness of morphology and connecting activities, has occurred in this area.

Case 2 Kirkjusandur-area (HA2)

On the following map the coastline of 1948 is traced with a thin line taken from an airphoto. Today's line (the thick line) is taken from the master-plan of 1982. This area has been filled up, except for the bulge that is planned for a ramp on a highway intersection that is to be located here.

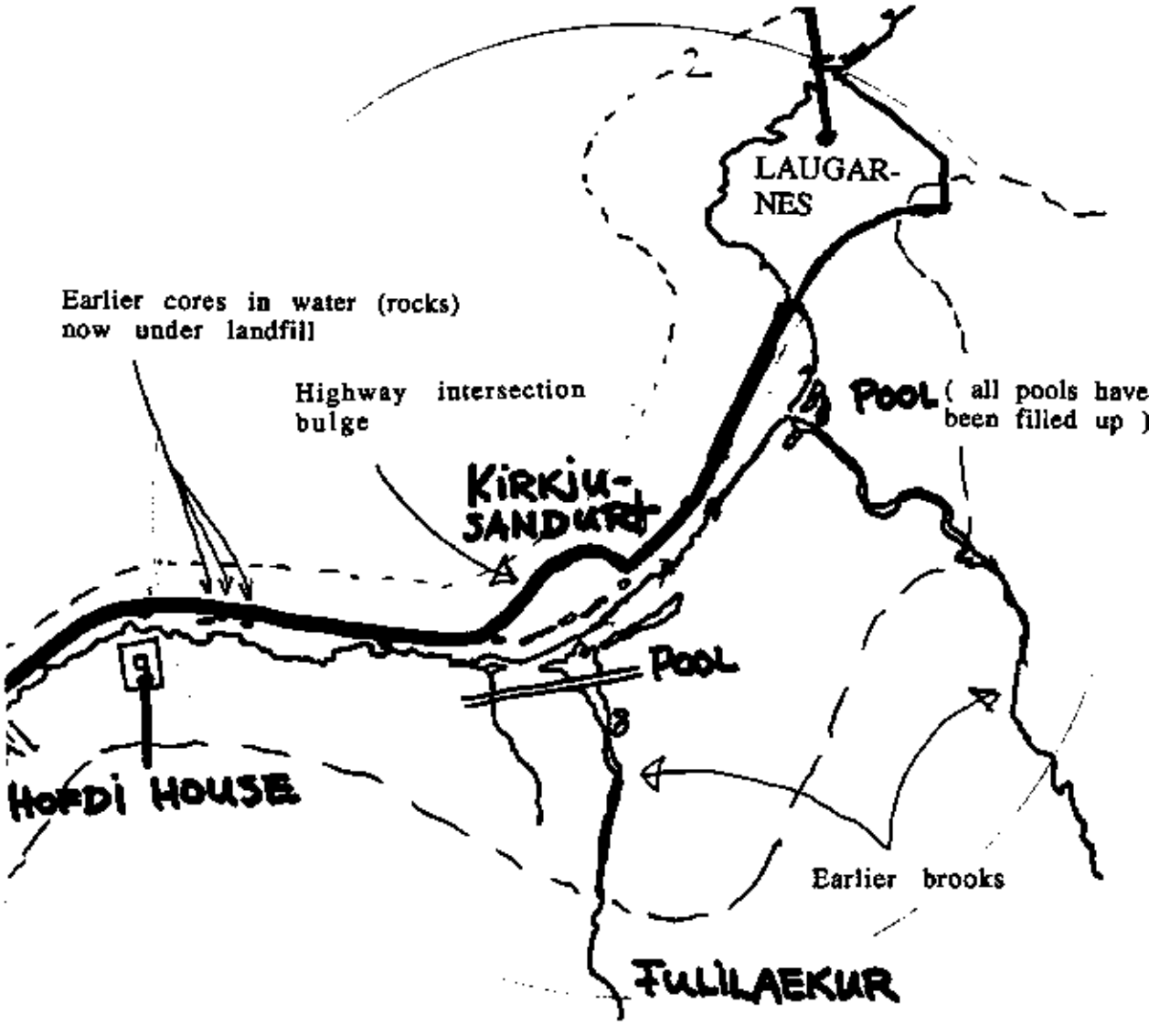


Fig. 139

The pools on this coast have been filled, the brooks have been put in sewers, and all cores in water at Kirkjusandur-coast have been submerged by the landfill that was created for the highway that runs here now. The coastline of Laugarnes-headland is largely intact, as shown in Fig. 139, but few cores are located here because the coast here is steep. In areas

approachable by cars, most of the beautiful seaworn rocks on the coast have been removed by people building their gardens. People had even started pealing off basalt pillars for this purpose. A sign has now been put here that forbids this activity[51].

The Engey-island is naturally connected to the Laugarnes-area because of an under-water ridge that goes between these two areas. This deeplying causeway was a most convenient link for the people who lived in Engey in earlier times, and horses could wade most of the way. The boat connection between Engey and Laugarnes was also rather easy here because shelter, from waves and currents, was provided by the island. Engeyians sometimes kept a horse in Laugarnes for their convenience. (See now a map of the island to get a sense of its dimensions[52]).

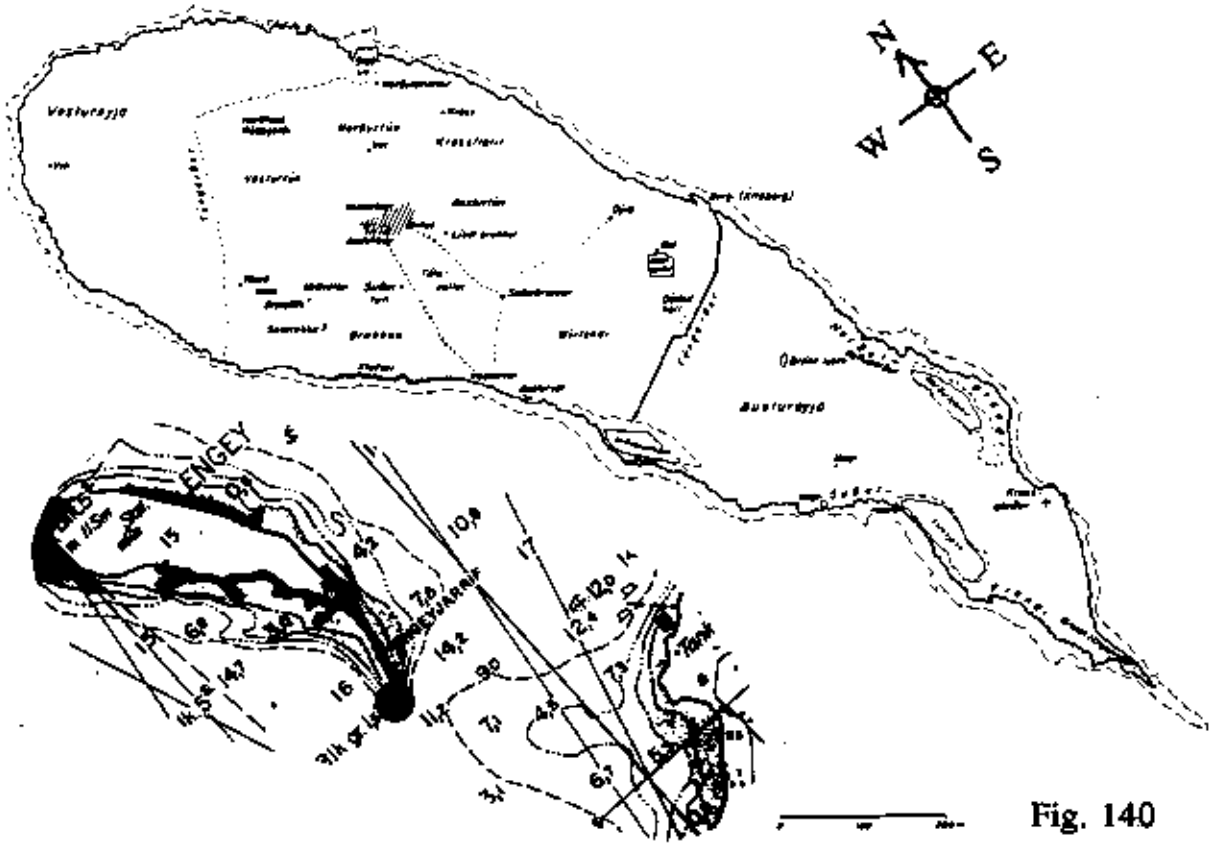


Fig. 140

Today, nobody lives in Engey and the people in the closeby land-areas have little possibility of enjoying what the island has to offer. These brief notes on the history of the island show us that the interrelationship has declined, but these notes also demonstrate that the island has the resources which when utilized, are capable of enhancing the interrelation between land and water in this area.

Case 3: Sundahofn-Area (HA3)

The original coastline (Fig. 141) is taken from the 1948 airphoto. The lagoon has been filled up and medium-level cores at the coast have been submerged by the harbor landfills. The filling of the lagoon resulted in the greatest loss of a core in this area. The lagoon was popular and many bird species, that now have all but vanished, used to be linked to it.[53]

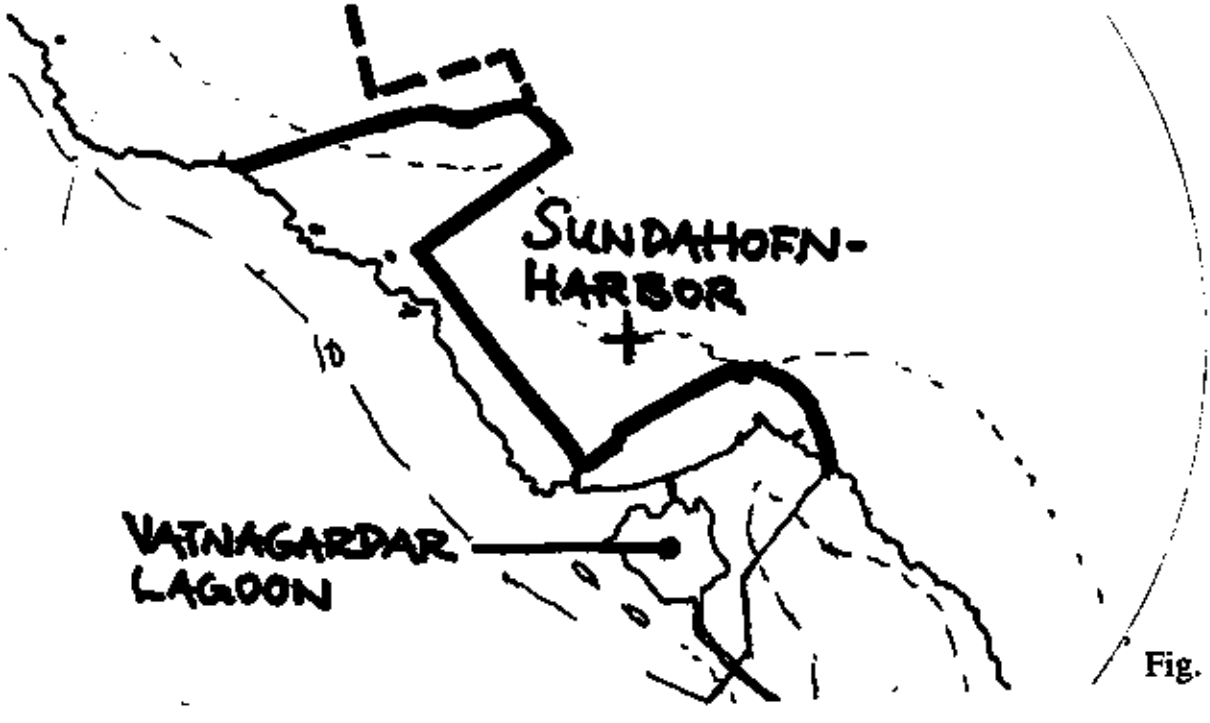


Fig. 141

The green Kleppur-area has a natural coastline, but because the coast is steep, only few cores are located here. In the newest master-plan ideas (1986) a harbor landfill, that will close off this area from the water, is proposed. This coastal area might have been a suitable place for a small pier for the sight-seeing ferry to Videy-island. (The ferry boat now leaves from the unpleasant corn-silo area).

Videy-island belongs to the Sundahofn-area, but no residential areas are located close enough to the coast to enjoy contact with the coast and the island. The view to the coast and the island is also largely blocked off by warehouses running along the coast. As concerns the lack of a contact to the island, the fact that Videy (as well as Engey) did not belong to the Reykjavik jurisdictionary until 1983 has been of decisive influence.

As the City of Reykjavik became 200 years old on August 18, 1986, the National Government and the National Church gave the ancient Treasurer's house and the Videy-church to Reykjavik, (together with some land they owned around them). Conditions for improved links in the future are thus provided, and the City of Reykjavik is now preparing a competition on the future of the Videy-island. See now a map of the island to get a better sense of its dimensions and resources[54].

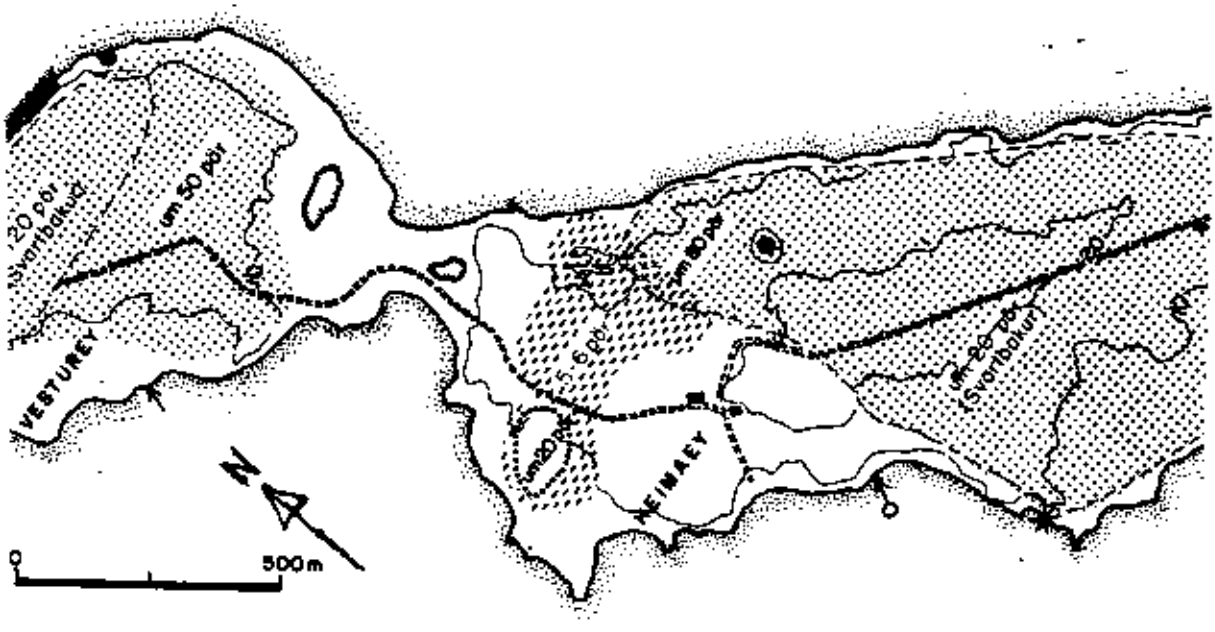


Fig. 142 In earlier times Videy was one of the most prominent Places in Iceland. Today nobody lives here

The next map shows the islands, and the areas connected to the land-cores (lakes), are important nesting-grounds in the northern part of the Reykjavik area.

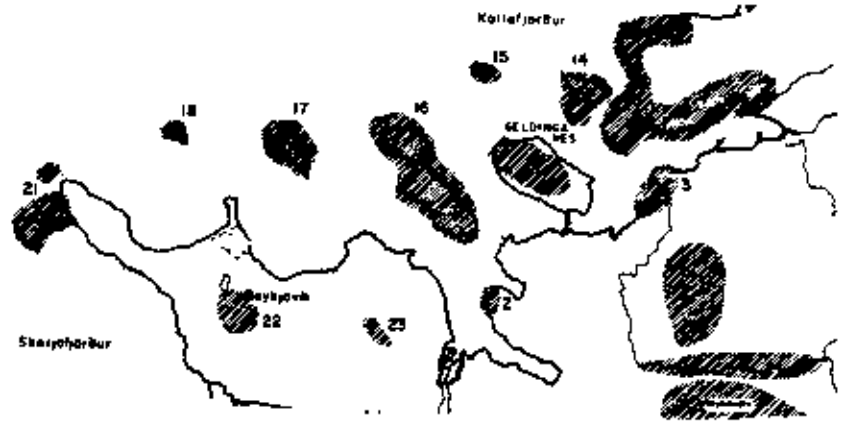


Fig. 142 Nesting-grounds at the northern part of Reykjavik

In earlier times Videy was one of the most prominent places in the country. It was the place of a large monastery, a State Treasurer's seat and a large farm. A fishing village was located in its east end. A brief sketch of the history of the island was given in the introduction to the case-studies. (See page 75).

Today nobody lives in Videy anymore and only about 10 years ago sightseeing tours to the island were started, (in summertime only). A construction of a bridge to connect the island with a bridge, over the shallow strait SE to Gufunes, would be inexpensive (see the map).

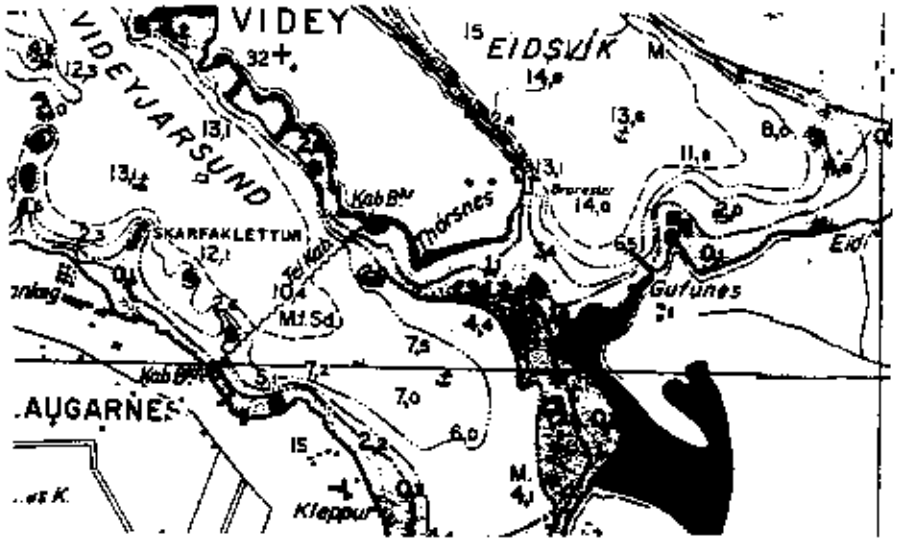


Fig. 144 A sailing-map that shows how shallow the water is in the straight between Videy and Gufunes

In summary one can state, by referring to the history of this area, that the cores (island, rocks, pools) can increase the land and water interrelationship in this area.

Case 4: Skulagata-Hofdi Area (CA1)

Fig. 145 shows the coastline of this area (from the Danish Army map of 1903), traced with a thin line. The line east of A', however, is taken from the airphoto (1948). The heavy line shows today's coastline, as it appears in the master-plan of 1982.

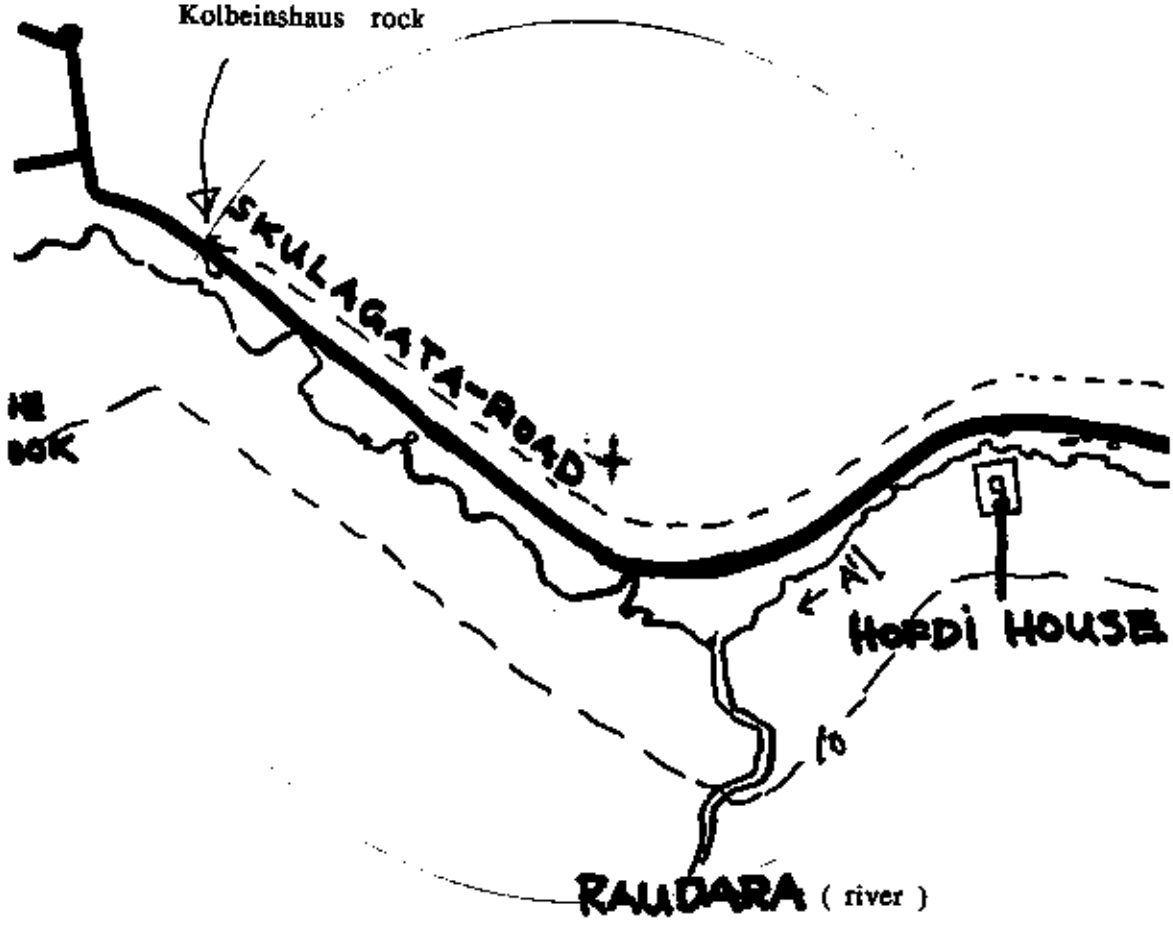


Fig. 145 Skulagata-Hofdi area

Because maps tend to leave small cores out, more cores are likely to have existed in this area before the landfills -- not least in the Raudara-river estuary. The landfill in this location was constructed in the early 1940's[55].

The most prominent core in water, was the Kolbeinshaus-rock. This rock, and the life on or around it, became known and loved by the whole country through the morning radio-programs of the State Broadcasting Service (Channel 1), which is located at this shore. The broadcasters used to describe the life here; birds, seals, and the rising sun to the east, seen from their studios. (See now the photo of Kolbeinshaus).

Fig. 146

Today, as all the cores in water in this area have been submerged by landfills, birds can still been seen here, sitting on the water, but they tend to be further out and not as visible as before. The Skulagata-Hofdi area did not have any large cores; islands or pools. With the landfills all the medium and human-size cores are gone, and today the interrelation of land and water in this area is poor. As Kolbeinshaus-rock got lost K. Benediktsson (a member of the City Council) suggested that a new Kolbeinshaus could be built further out in the ocean. This is a good idea and should be extended to the recreating of a convex/concave shoreline with landfills beyond today's highway-landfills. Cores would be created outside (and within) these new landfills.[56] The contact between land and water, which is lost today, because of loss of cores, can thus be reestablished.

Case 5: Skarfaklettur-Area (CA2)

The fine line on the following map shows the coastline, and the rocks in water, as they appear on a 1948 airphoto. The coastline is similar to this today. The bold, dotted line, shows harbor landfills as proposed in the 1982 master-plan.

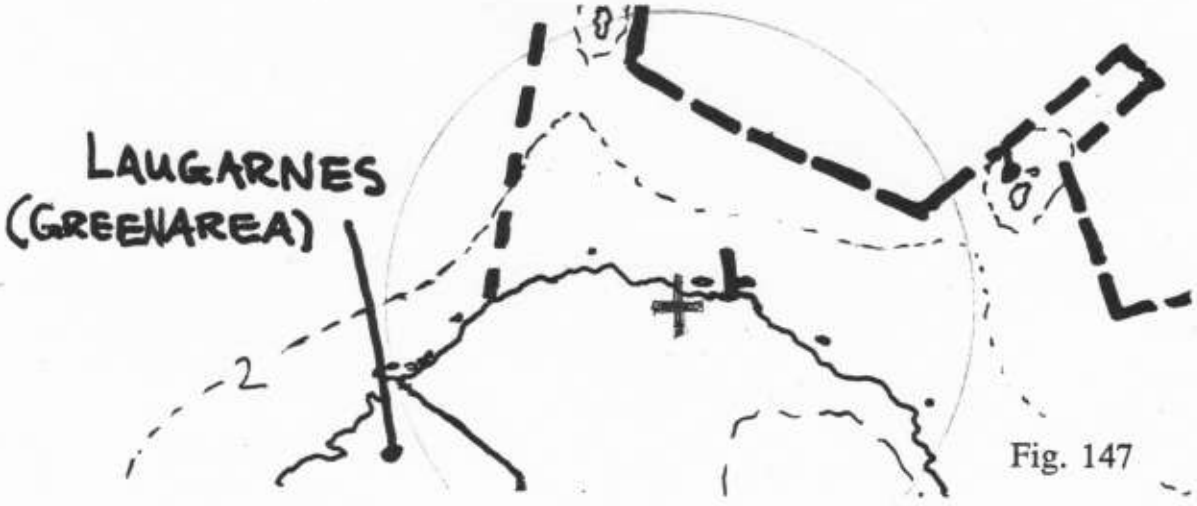


Fig. 147

If carried out this landfill would submerge both the smaller rocks at the coast, as well as the prominent Skarfaklettur-rocks (Scurvy rocks) further out in the ocean. The following photo shows the larger Skarfaklettur-rock.

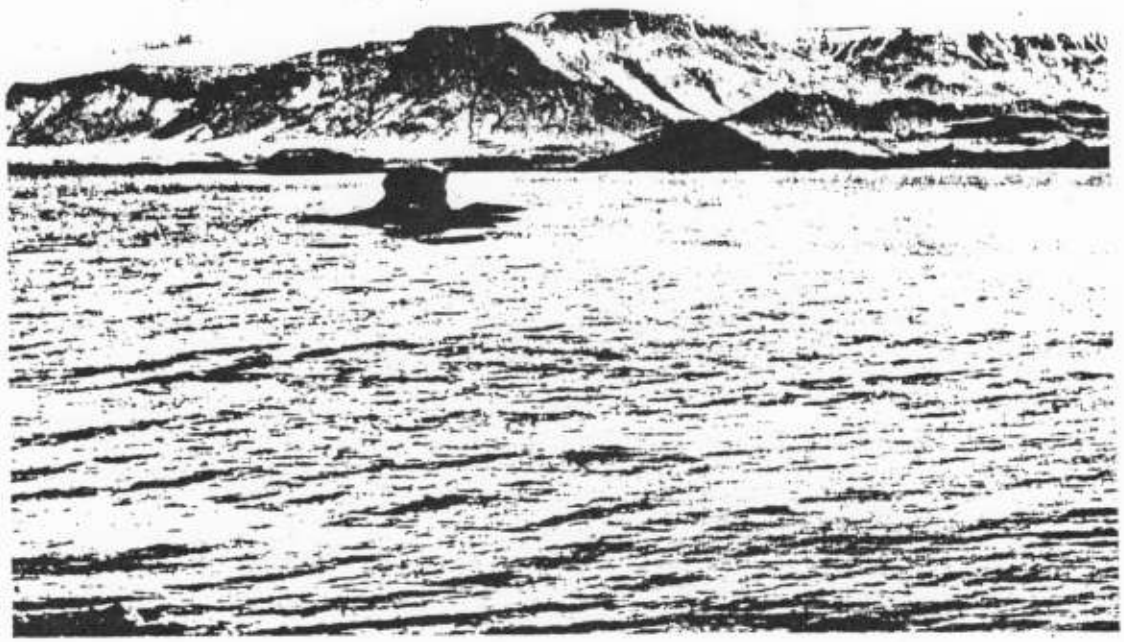


Fig. 148 Skarfaklettur seen from land
(Videy and Esja-mountain in background)

On a line running north from Small-Skarfaklettur more skerries used to be located. G.R. Gudmundsson explains their location in an essay on place names in the area[57]:

> "In Videy-sound, between Videy and the Laugarnes-farm, is Skarfa-sker, Skarfaklettur and Palsflaga (Palsflak) are located, but the Baejarsker, Hjallasker and Flosur-skerries are located closer to Videy" (p. 302)

Gudmundsson shows the first three coves on his map but not the last three. The approximate location of them may be concluded from the following sailing map.

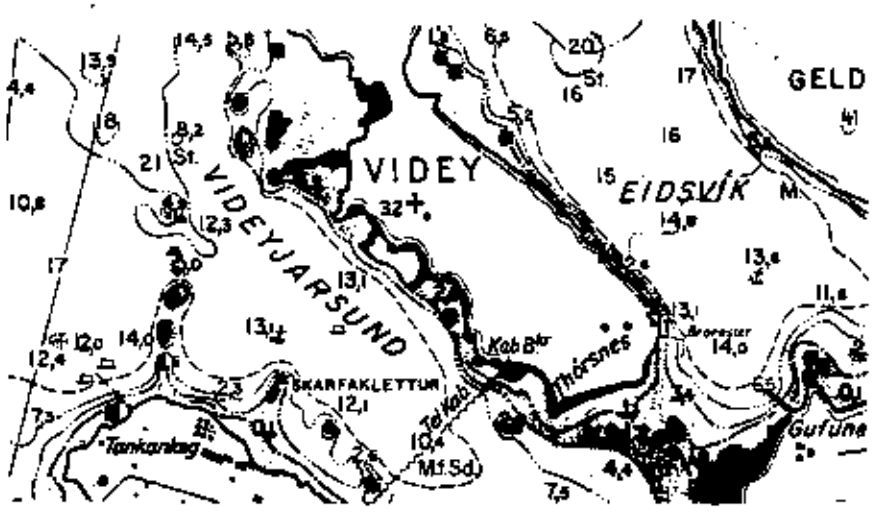


Fig. 149
Videy-sound

In an outline of the history of the Reykjavik Harbor one of the skerries north of Langarnes is said to have been blasted with dynamite because of the sailing route.[58] As the Skarfklettur-area is a convex headland with a steep coast, no major pools exist in the area (cores tend rather to be located in flat areas at concavities).

An interrelationship between land and water is created by prominent rocks in the water because they attract birdlife and people enjoy the scenery.

Case 6: Gelgjutangi-Area (CA3)

The thin line of the following map, displays the coastline and cores (located on both sides of the coastline), as they appear on the airphoto from 1948. The bold line shows today's coastline. (Master-plan 1982).

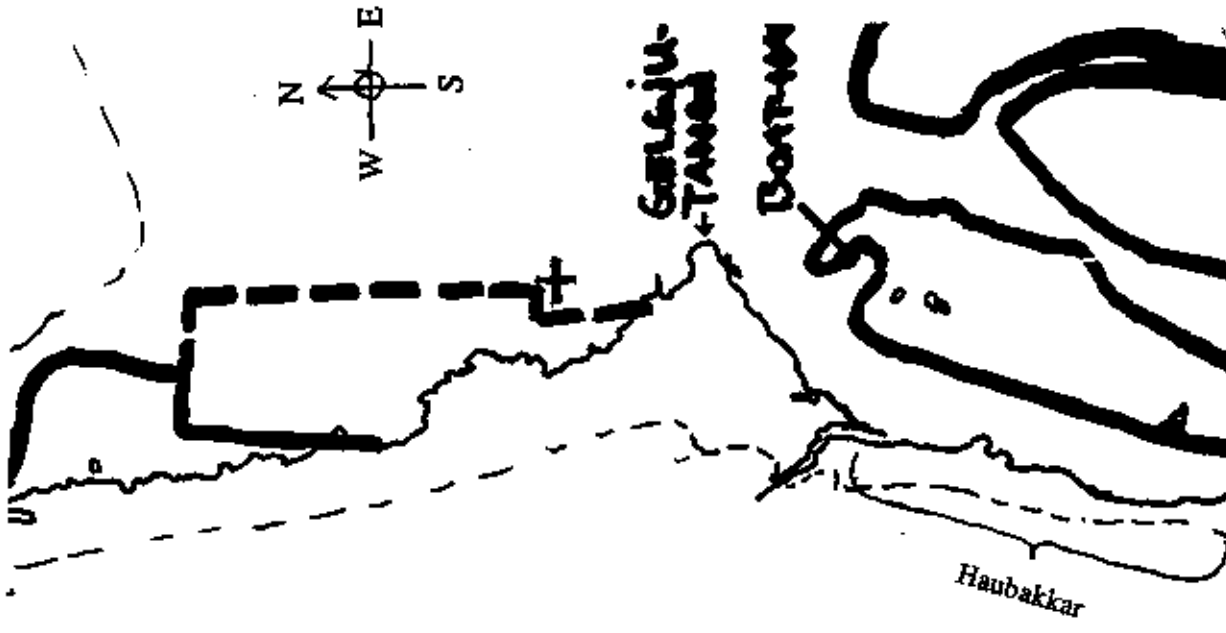


Fig. 150 Gelgjutangi area

As the map shows, cores in water have been lost under the landfills in the northern and southern parts of this area. Cores in the middle section are still preserved, but the proposed landfill (the heavy, dotted line) will submerge most of this area in the future.

When the bay was still a mudflat, a multitude of land- and water-cores on micro-scale was located in this area. This provided a haven for water fowl. Their number have greatly decreased in the area since the landfills were made[59]. The Grafarvogur-bay east of Ellidavogur-bay, is still a mudflat and here we can observe what the Ellidavogur ecology used to look like earlier. (See Fig. 151).

Grafarvogur
(looking west)
Fig. 151

The "Sounds"
(mudflats dark gray)
Fig. 152

The picture-text to Fig. 151[60] explains:

Grafarvogur-bay at ebb tide. In the frontal part various species of birds can be seen searching for food in the mudflat. For instance, golden ploves, jadrakan, redhawk, oyster-catcher, ringed plover and ducks. This is a very important feeding-ground for migrating birds, especially after the mudflats in Ellidavogur-bay were destroyed (p. 52).

At the Haubakkar coast, in the southern most section of the Gelgjutangi-area the steepness of this coast influences that few or no cores at the the coast's medium level exist here. On micro-level a few cores, however, exist. At the more flat Gelgjutangi headland, on the other hand, some cores exist, both on the medium and man-sized levels.

- - -

The findings of this chapter I sum up, in a comparative way, in the following matrix. (The sizes of the X's indicate differing strength of relations).

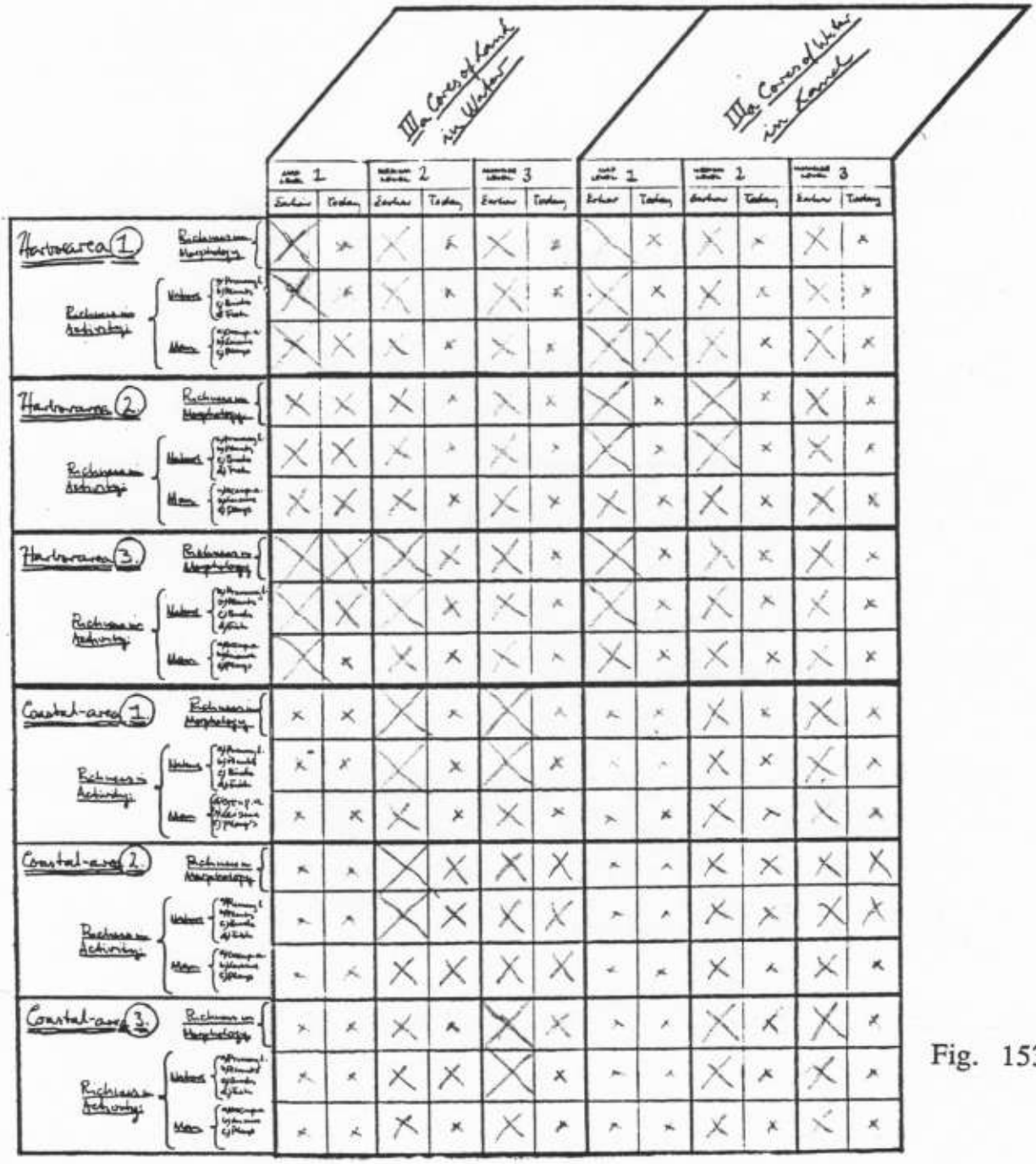


Fig. 153

This forms the background for the grouping of the six cases into the cells of the two following diagrams:

		Cores in water (Size-groups a. numbers)	
		more present	less present
Richness in activity	much	HA3 CA2	
	little		HA1 HA2 CA1 CA3

Fig. 154

		Cores in land (Size-groups a. numbers)	
		more present	less present
Richness in activity	much	HA1	
	little		HA2 HA3 CA1 CA2 CA3

Fig. 155

This result answers Question IV positively; yes a link, between richness in cores and the richness in the interrelation between land- and water-areas, does exist. The reversed findings--i.e. that areas with fewer cores have less interrelating activity--also supports my hypothesis.

CHAPTER 10: Possible future directions and practical applications

This dissertation attempts to make a contribution in three different areas. It has a design theory component, a philosophical component about the nature of complementarity, and a component that deals with the four design-principles, their testing and an identification of their practical application in the planning of coastal zones.

As the theory section demonstrates, today's design-theorists have had difficulty coming to grips with the fragmentation of the design field, and the form theories of the field. In addition, the theories of form which I think could contribute to unification are poorly developed, as K. Lynch states so candidly in A Theory of Good City Form (1981).

In reflecting on this dissertation's contribution to the development of a form theory a return to Kevin Lynch's discussion of the shortcomings of present theories may be useful. In the epilogue of A Theory of Good City Form Lynch discusses the problems and the desirable directions for further theory development:

> This is the end of it, and we should reconsider. The theory has a number of deficiencies. Most glaring is the lack of a complementary theory on how cities come to be and how they function. I have made assumptions of that kind, but the theory is not the comprehensive view that the cosmic or organic theories were, and that the economic and behavioral analyses are not. Until it is linked to functional assertions it remains incomplete.... More than an accusation of incompleteness can be laid against these proposals. In comparison, say with the organic theory, which is a coherant statement about what a city is and how it

> should be, based on the metaphor of a living organism... (p. 319).

The points Lynch indicates here as qualities missing in his normative design theory, i.e. lack of a comprehensive, cosmic and organic view, I think can be seen as the strongest quality of my theory. In the dissertation I demonstrate (sometimes quoting Koh's work) that the form principles--like the Circle (densest packing of elements) and Concavities/convexities--correspond to ecological maxims or prototypical features, the Circle to the necessary spatial density of ecosystems, and types of concavities to the various types of ecological niches.

Biology and ecology have established that functions follow form. My case-studies from Reykjavik demonstrate that human activities and functions also tend to follow form. This clarifies the valuable insight that form can be used as a tool to facilitate desired functions and connections in design and planning.

A future project of interest might be to spell out in some detail the metaphorical relations between organisms and the four principles of my form theory. The enclosure of an organism, which is a parallel to the enclosure of land/water harbor area, has, for instance, the function of fending off external disturbances. This obviously has the result that the internal functions are more coherent and the internal linkages are more fully developed, and are thus more intense. For those design theorists who might want to do further work on the subject, or assess the prospects of my form theory for extended

applications, I refer to Lynch's list of preformance criteria for a form theory which I discuss in the introduction to the theory section.

This dissertation's case studies can be used as a model to do a similar studies for other coastal areas, and the step from such studies to a plan or a list of proposals for improvements is a direct one. A study of this type, can also be made on other interfaces, i.e. on how city and landscape areas meet, or a neighborhood and a park, or a house and a garden.

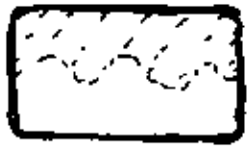
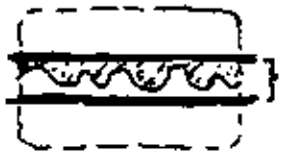
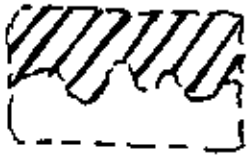
In my view, the most interesting case study findings were discovered in the study of Question III, on complementarity. These case studies demonstrate that functions on the water-area and the adjacent land-area are often incompatible--but that in cases where they <u>are</u> compatible (complementary), increased interrelating functions occur between them. The main reason why this incompatibility of adjacent areas has happened is that the knowledge on how to order land-uses as pairs of complementary functions in a plan is poorly developed in Reykjavik (and presumably in many other cities). A second reason why land-uses on coasts and adjacent water-areas are so incompatible, is that the water-areas are most often not studied in modern urban planning and they are usually outside the defined planning area.

To correct this, planning areas at coasts should be expanded to include the adjacent water-areas. To include the water-areas means that a study of the qualities of the various segments of the sea-areas need to be carried out, and finally, the various water-areas need to be included in a land- and sea-

use plan.

A useful first step in such a work process is to formulate the ideal planning goals for such areas, and a second step, to identify the means available for realizing these goals. (See the following table).

Planning goals for enhancing the interrelationship between urban-areas and adjacent water-areas.

	Goals	Realization of Goals
	1. Adjacent land- and water-areas shall be seen as a planning unit.	1a. The size and shape of the land- and water-areas shall be defined. 1b. The plan shall facilitate communication between them.
	2. The interface-areas between land and water shall have rich forms and activities.	2a. The concave/convex forms shall be created or recreated where they have been erased. 2b. The interface-area shall have activities that connect land and water (marinas, recreation,residences).
	3. The qualities that are complementary in these areas shall be improved.	3a. Establish residential areas (on landfills if necessary) at water-areas that possess natural beauty. 3b. Remove activities that do not require a coastal location.
	4. Interdigitated cores of opposites shall retain a relation to their source.	4a. Cores of land at sea (islands, rocks) shall offer activities useful for inter-relationships

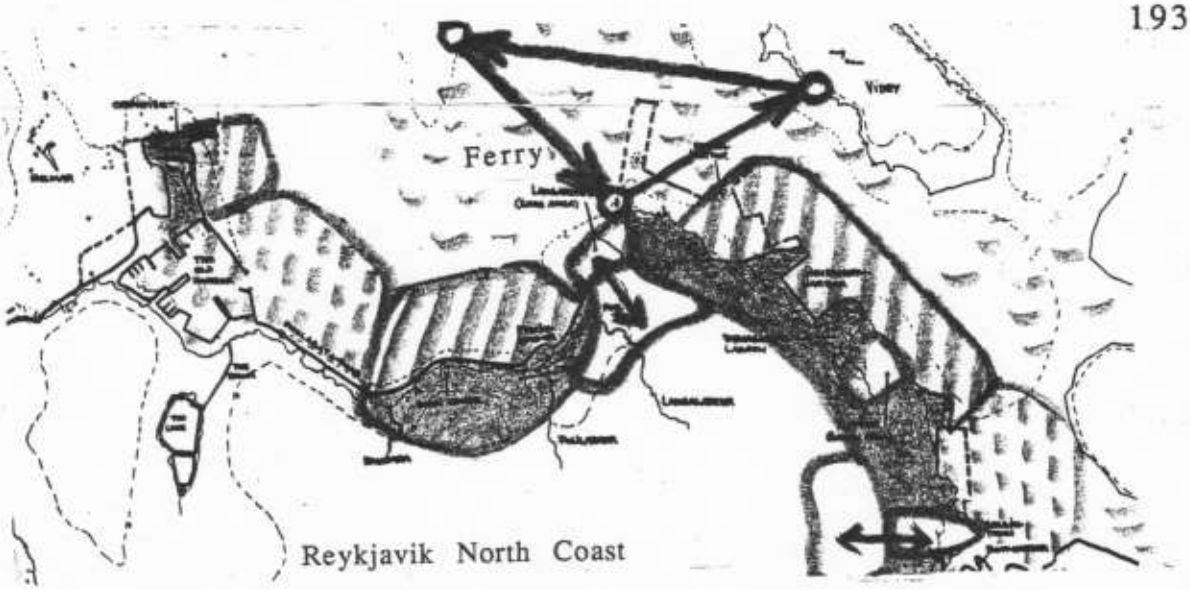


Fig. 158

In order to recreate the concave/convex quality of the coastline, decisions on where to make landfills have to be based on studies on water-depth, wave-direction, location of sewage-channels at the coast, etc. No studies of this type were made for the landfill sketch that follows. The sketch is meant merely to illustrate what such a landfill could look like in principle.

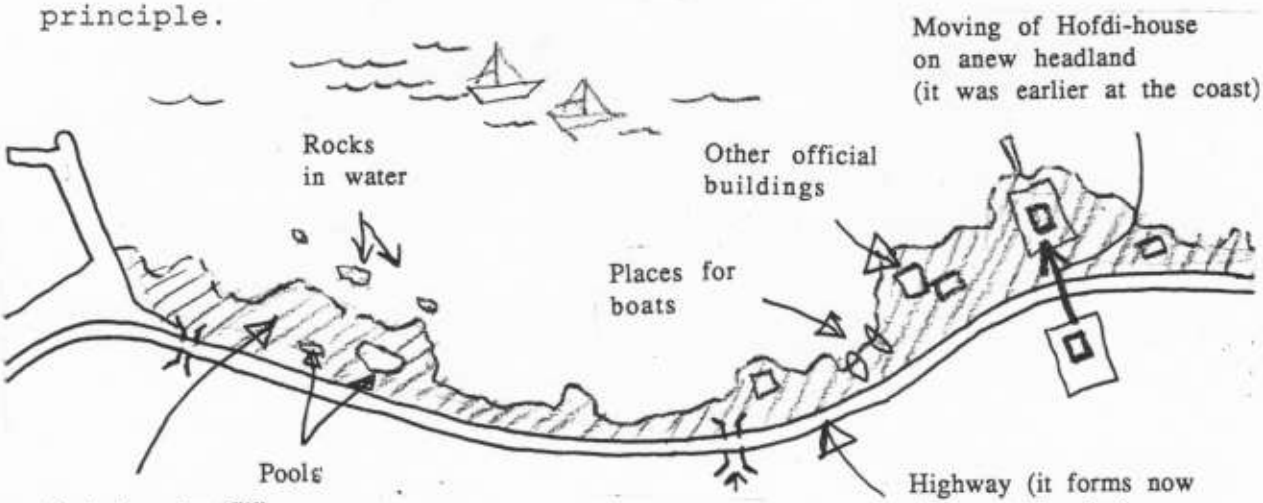


Fig. 159

A development has now started in Reykjavik which orients land-uses in the town-center to the harbor. Examples are seafood restaurants and residential units at the harbor. Some of the small-scale harbor activities, such as small fishing boats, repair shops fit well with such land-uses. If recreational and tourist facilities would be extended here then a vivid link and complementarity between the urban- and water-area could be achieved. Such harbor-areas are popular in many foreign countries. (See Figs. 160-161).

Fig. 160 Santa Monica Pier in Los Angeles

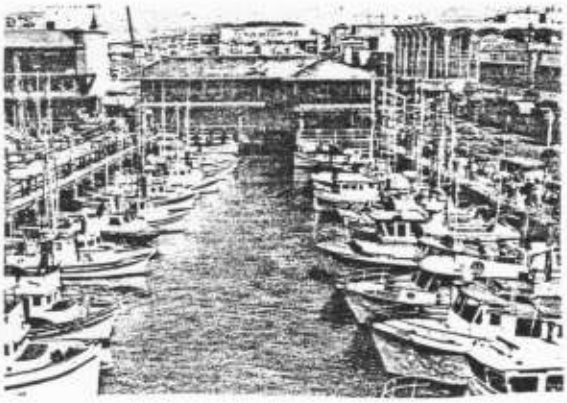
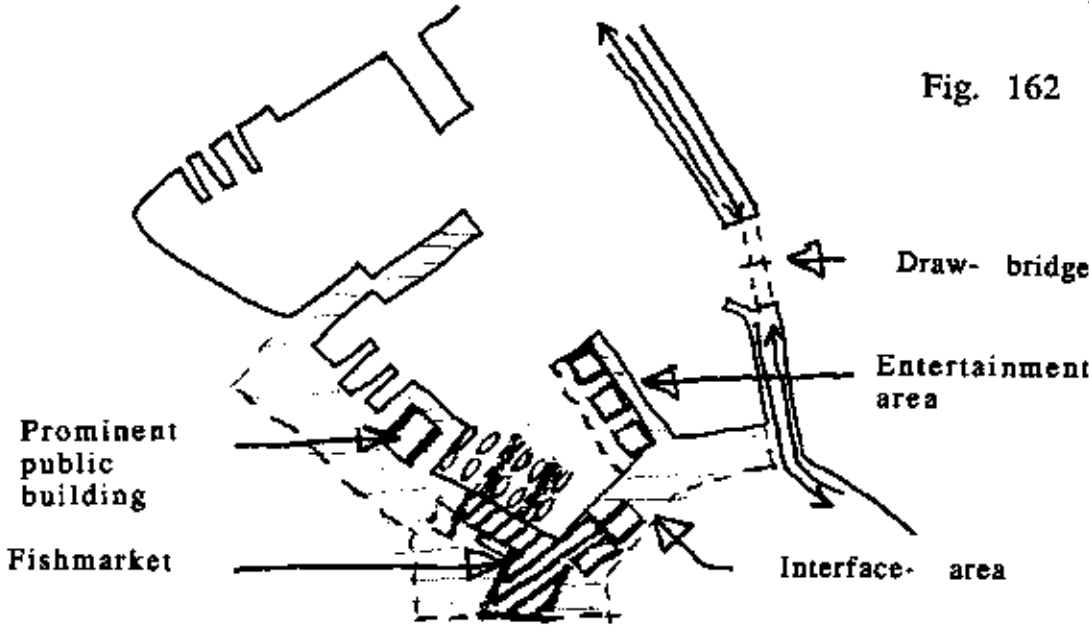


Fig. 161 Fisherman's Wharf in San Francisco

If the link between the town-center and the harbor is to be established, the thoroughfare road cannot run along the harbor. This road either has to be put into a deep-lying channel or an alternative road connection needs to be created by building a drawbridge over the entrance to the harbor. If either of these alternatives are taken, then the area where this road is now planned can be used to provide space for the connecting interface activities. (What follows is a sketch for a design of the interface).

Fig. 162



One of the principles that appear in this sketch is worthy of special attention. This is the principle of making use of convexities (wide piers) protruding into the water-area. The clarity and prominance achieved through this is worthy as a location for an official building like a city-hall, or an opera, as was done in the famed example in Sydney, Australia. In the U.S.A. wide piers are often used for amusement-facilities and restaurants. A view of the water and the coast or harbor is provided through this, and the location in and above the water also produces a pleasant feeling.

Final Remarks

This dissertation started with a theoretical discussion of the lack of connections between environmental areas such as an urban area and a water-area. It sought to bring to light what may be deeplying reasons for this widespread lack of relations and connections among such areas. The scheme of dissection,

which has been highly successful in modern science, has been carried over--the dissertation argues--to other fields, such as environmental design. In this field, however, the lack of connections between the rather isolated disciplines, has more drawbacks than in the sciences.

The dissertation then developed four design principles to help connect and interrelate environmental areas. These principles, at first, seem to be very abstract but my hope is that the case-studies and the schematic design proposals for the land/water interface in Reykjavik, have helped outline a route that designers can follow in applying the theoretical findings of the design theory to practical design projects.

NOTES

INTRODUCTION SECTION

[1]This quote is taken from the introduction to the encyclopedia in its first volume.

[2]From the essay "Building Dwelling Thinking" in M. Heidegger's collection of essays called Poetry, Language, Thought (1971).

[3]The dissertation was written at the University of Pennsylvania, Philadelphia, under the guidance of Prof. Ian McHarg.

[4]See the literature list for the references.

[5]The dissertation was submitted at the University of Toronto in 1973.

[6]The Latin title means: The spirit of place.

[7]M. Southworth, a professor at the University of California, Berkeley, is now preparing selected chapters of the manuscript for publication.

[8]Because Oriental philosophies are traditionally oriented towards integration, it does not come as a surprise that a Japanese architect shows an interest in the way land and water interrelate.

[9]These three photos are all from the dissertation Der Einfluss des chinesishen Konzeptes auf die moderne Architektur by Chuan-Wen Sun.

[10]A native of Reykjavik, I have worked in Reykjavik's Planning Office for more than six years and I have written

the book Reykjavik: Vaxtarbroddur English title: Reykjavik: The Urban Frontier in Iceland (1986). I am therefore in a good position to do this study of Reykjavik.

CHAPTERS 1-2: PHILOSOPHIC BACKGROUND

[1]See the first chapter of Entropy: A New World View by J. Rifkin (1980) and the preface to Order out of Chaos (1984). The preface is written by A. Toffler.

[2]This has been advanced within neurological science, and the power of the mind over the body has been applied in with the biofeedback techniques.

[3]Order out of Chaos pp. 214.

[4]Ibid. pp. XV.

[5]Ibid. p. 206

[6]Most books on visual matters deal with this. T.D.K. Ching puts this well in his book Architecture: Form, Space and Order:

> In all cases, however, we should understand that figures, the positive elements that attract our attention, could not exist without a contrasting background. (p. 110)

[7]In "Biographical Sketch" in Niels Bohr, Collected Works (1972) it says on this:

> ...From the epistomological point of view, the discovery of the new type of logical relationship that complementarity represents, is a major advance, which radically changes our whole view of the role and meaning of science. (Vol 1 p. XL)

[8]Capra says on this in Tao of Physics (1977):

> The creation and destinction of material particles is one of the most impressive consequences of the equivalence of mass and energy. (p. 187)

[9]Greek vases are famous for this and Y. Ashihara writes about this in many places in The Aesthetic Townscape (1983) where he explains his studies of Italian towns. The figures from Rome are taken from his book. (p. 102).

CHAPTERS 3-4: THEORY BUILDING

[1]In the natural sciences and the arts the search for the missing unifying theories has been going on for a long time. Many theorists believe that form may be the key towards such theories.

In a collection of essays on the subject Aspects of Form (1951, 1968) H. Read says in his preface:

> ...if the present trend continues other universities (than Techicon at Hafifa) may soon be using General Morphology...as a way of displaying the unity of many unduly separated academic disciplines. 'This is a world of form and structure and can only be properly understood as such' is the leitmotiv of this new unifying discipline. (p. XI)

[2]R.B. Fuller puts the quest of a scientist to find valid generalizations well in his book Buckminster Fuller. An Autobiographical Monologue/Scenario (1980):

> I am not trying to imitate nature, I'm trying to find the principles she uses. (p. 196)

[3]The term fractal is taken from the word "fraction". This is to underline that the whole can be seen, understood from a fraction. This is, for instance, related to theories

like "pars pro toto" in art.

As one has found a formula for a fraction, a computer can be used to draw the whole that displays a hierarchy of repetition. This Mandelbrot calls "self similarity" within a structure.

Of most relevance for my study is the example he takes on this on a coastline: you can change levels of scale (e.g. height of the observer) and the coastline always looks the same.

This gave me the idea to divide the study of concavities/convexities into many levels of scale (three levels proved to be practical).

[4]This visual analogy between the elements of the T'ai Ch'i symbol and the four patterns at an interface has, as far as I know, not be discovered by others before.

[5]The word "interface" is one of the new double-awareness words that are opening doors to unexpected new insights.

An example on this is the following excerpt cellular biology from the magazine Science Digest (Dec. 1984):

> ...the key will be to learn how to manipulate interfaces to achieve a synthesis of aggregate systems that achieve new functions (p. 88).

[6]The books of J. Itten and D.A. Dondis provide lists of complementary features in the visual arts. I extend this to complementary features in urban and natural (e.g. land/water) environments.

[7]In city planning radial schemes are known from, for

instance, Paris and Washington D.C. This scheme is often called "point de vieu." The radial steets often provide a view to official buildings, monuments, fountains, etc.

[8]The picture and the text are from the book The Aesthetic Townscape (1983).

[9]The picture and the quotation were taken from his paper "An Experiment in Revealing the Sense of Place: A Subjective Reading of Six Dalmatian Towns," prepared for the Conference of the Society of Phenomenology and the Human Sciences (1982).

[10]From Ashihara's book The Aesthetic Townscape (1983). The pictures are from p. 102.

[11]My exchanges are somewhat related to the "interchanges," in transportation which appears as pattern 34 in the book A Pattern Language (1977).

[12]From The Aesthetic Townscape (1983).

[13]Ibid.

[14]From "Lifriki fjorunnar" in Votlendi (1971). My translation.

[15]Ibid.

CHAPTERS 5-9: THE CASE-STUDIES

[1]A. Ola describes the possessions of these churches in the essay "Kirkjur med Sundum", pp. 97, in his book Sagt fra Reykjavik (1966).

[2]A history of these commercial places is given by H. Thorlaksson in his essay " Holmurinn vid Reykjavik" pp. 92 in Reykjavik i 1100 ar (1974).

[3]A. Ola wrote a book on Videy in this period: Videyjarklaustur (1969).

[4]In the biography: Skuli Magnusson Landfogeti (1911), J. Jonsson describes many of Skuli's activities in Videy.

[5]See the 2nd volume of Thor Jensen: Minningar, Framkvaemdaar (1955) written by V. Stefansson.

[6]See book on agriculture in Reykjavik: Sveitin vid Sundin (1986) by Th. Valdimarsdottir.

[7]All the master-plans "qouted" or shown are taken from the book Reykjavik, Vaxtarbroddur (1986), which is the planning and environmental history of Reykjavik written by the author of this thesis, T. Valsson (1986). The originals are kept at the City Planning Office of Reykjavik.

[8]At the end of this book there is a fold-out scheme that relates the main nature and man-activities (seven of them) within each of the six case-study areas to the form-principles as they appear on the coast (the columns).

[9]This is one of the most important points on the utility of concavities.

[10]The data-sources are to be found in the Literature List.

[11]All these main form-features are collected on a fold-out map at the end of the book.

[12]This picture is a reduction of the fold-out map at the end of the book, to which I refer for the further serutionizing of the morphological features discussed in these upcoming case-study chapters.

[13]The map to the left was made by Hoffgaard in 1715. It is taken from the book Saga Reykjavikur (1929) by J. Jonsson.

[14]The map to the left is by E. Hallgrimsson, published in Saga a yearbook of "Historical Society" 1973.

[15]A photo by S. Eymundsson in Ljosmyndir Sigfusar Eymundssonar edited by Th. Magnusson (1977).

[16]These booklets bear the names, Reykjavik 1958 and Reykjavik 1962 published in these years by the Sjalfstaedisflokkur party.

[17]Taken from Reykjavik, Vaxtarbroddur, T. Valsson (1968). The whole original map is kept at the Survey Dept. of the City of

Reykjavik.

[18]These photos are taken from Reykjavik Vaxtasbroddur, Valsson (1968). The models are kept at City Planning Office of Reykjavik.

[19]The diagrams on the population numbers of eleven of the species appear at the end of the text.

[20]The Peterson's report is called: "Nokkrar hugleidingar um breytingar i fjolda fugla a talningarsvaedinu Grandi-Grafarvogur a arunum 1956 - 1985." IINS (4.1 1987).

[21]INNNES-Natturufar, minjar og landnyting (1985).

[22]Ibid., p.33-35.

[23]Ibid., p.47.

[24]Ibid., p.69.

[25]Ibid., p.69.

[26]Drawing by Aage Nielsen-Edwin. Based on a map by Sveinn Sveinsson from 1876, photos etc. Published as a poster by Arbaer Museum.

[27]From the book Frasagnir (1972)

[28]From Fra Hlidarhusum til Bjarmalands (1948).

[29]Ibid., p.72 and Gvendur Jons og eg (1949) p. 49, by H. Ottosson.

[30]By F. Press and R. Siever (1975).

[31]From Innnes (1985) p. 66. The number of farms is 107 and parcelled-of farms is 83.

[32]From Island of Dets Tekniske Udvikling Gennem Tiderne Th. Krabbe (1946), p. 109.

[33]See Folkid i landinu pp. 152.

[34]See Sagt fra Reykjavik, A. Ola (1966) pp. 97.

[35]See Arbok 1986, Listasafn Sigurjons Olafssonar. An essay by Th. Magnusson pp. 71. All the information on the history of Langarnes is taken from here.

[36]From Reykjavik midstod thjodlifs, (1978), in an essay by

G.R. Gudmundsson p. 308.

[37]From "Agrip um sogu hafnar" prepared for a board meeting of Reykjavik Harbor (Feb. 9, 1984).

[38]"Kleppskapt" undated (prob. 1986). Kept at the Planning Office of Reykjavik.

[39]Published in Landnam Ingolfs (1986).

[40]From Reykjavik midstod thjodlifs (1978) p. 301.

[41]From Innnes (1985) p.78.

[42]The historical overview that starts here is drawn from most of the books on Reykjavik that appear in the literature list.

[43]Some of the data on the development of harbor areas is taken from "Agrip um sogu hafnar" prepared for RH (Feb. 9, 1984).

[44]Today's road system and location of building has largely followed this plan but the shapes of landfills and piers have changed somewhat.

[45]Most of the information on this area is taken from a BA thesis in history on Skuggahverfi by A.S. Arnorsdottir published in Landnam Ingolfs (1986) pp. 99. Two other usefule essays on this same area are also published there.

[46]Landnam Ingolfs (1986) p. 110.

[47]The report is called "Laugarnes" but is undated (1986?)

[48]See A. Ola's "Holmskaupstadur-Kaflar ur sogu Orfiriseyjar" in Gamla Reykjavik (1969) p. 267.

[49]A good account on children plays connected to these features - e.g. the largest rock - Krinsteinn - in the harbor can be found in Fra Hlidarhusum til Bjarmalands (1948) pp. 66.

[50]Diagram and picture from a historical essay on this industry in Sagnir (1984) p. 93-100.

[51]An interview with Birgitta Spur the director of the Olafsson Museum in Laugarnes. In Helgarposturinn (1986) p. 24.

[52]The map shows place names in Engey. It is taken from an essay on the subject by B. Hafstad published in Landnam Ingolfs (1986) p. 78-85. The insert map is from a Danish sailing map from 1959.

[53]In the bird-count reports at the IINS notes are made on the link of these species (ducks, oyster catcher...) to the lagoon and to the mudplains in Ellidarogur.

[54]Nesting-areas in Videy. A map from the Tunnnes-report (1985) p.50.

[55]H. Jonsson, former Director of Parks, in an interview with the author (1986).

[56]The author of this thesis has made a proposal on this, published in his book Reykjavik. Vaxtarbroddar (1986) p. 99.

[57]Published in Reykjavik midstod thjodlifs (1978).

[58]"Agrip um throun hafnar" (1984) p. 11.

[59]Bird-count reports at the IINS.

[60]Photo no.10 in the Innnes-report (1985).

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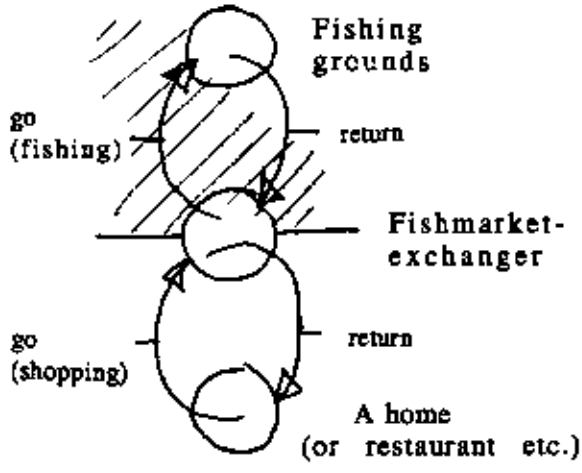
GLOSSARY

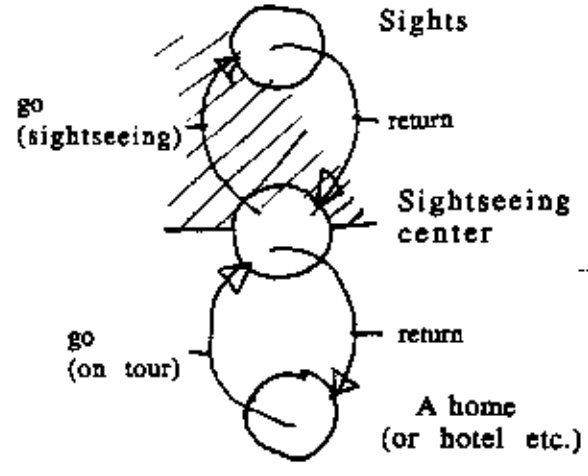
ACTIVITIES (BIOLOGICAL). In this dissertation, the term "biological activities" is used to refer to the presence and living functions of natural organisms. For the purposes of this analysis, four specific types are of interest: 1) primitive species at the location of the food chain (plankton, algae, worms, insects), 2) plants, 3) birds and 4) fish.

In ecological systems of any given location--e.g. in a concavity on a shore, in a lake, or on an island--some interdependency between these biological types occurs. An example: primitive species which occur in mudflats, is a necessary precondition for the existence of some species of wading birds. See LINKS (BETWEEN ECOLOGICAL AND MORPHOLOGICAL FORMS).

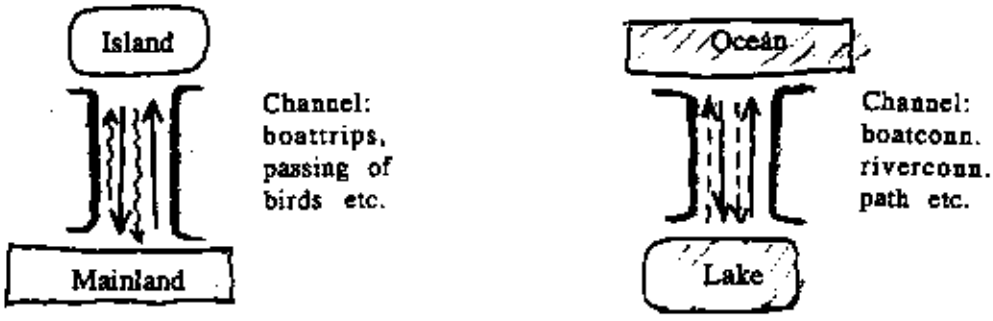
ACTIVITIES (HUMAN) In this dissertation, three kinds of human activities are of importance: 1) occupational activities, 2) adult leisure, 3) childrens' play. When they occur in a coastal area, some of these activities can be considered INTERRELATING ACTIVITIES in that they serve to "relate" the coastal zone's physical components. For example, the activity of operating a ferry boat connects an island to the mainland, and the activity of birdwatching visually connects close-by islands with the coast. See RICHNESS (IN HUMAN FUNCTIONS) for a definition of the components and types of such activities.

EXCHANGER A center for human ACTIVITIES (often located in the middle of a land/water interface)--a center that functions as an exchanger between activities occurring in the water-area (e.g. fishing) and activities in the adjacent urban area. Examples: fish-market, and a center for sightseeing tours with boats.

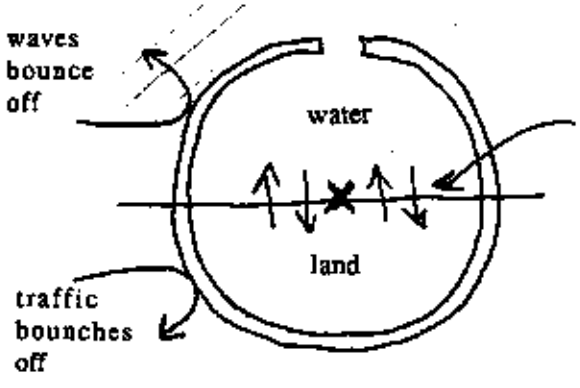




CHANNELS. Contact routs between CORES and their parent realm. INTERRELATING ACTIVITIES occur in these channels. These activities are both human and biological ACTIVITIES. Between the cores in water (e.g. islands) and a mainland these channels can e.g. contain boattrips, shouted signals, visual contacts and passage of animals and birds between the two elements. Between water-cores in land (e.g. lakes) and an ocean, a brook or river is a "medium" that can channel most of the activities belonging to this type of channel.



CIRCLE (PRINCIPLE I--ITS FUNCTIONING). This dissertation demonstrates that the density, roundness and enclosure (together with some secondary features of the Circle, see p. X) facilitates INTERRELATING ACTIVITIES between a land- and a water-area. The idealized example would be a circular harbor area where the water and urban halves of the circle are protected from external disturbances and thus allows the maximum of interrelating activites.



Idealizing basic qualities of the circle

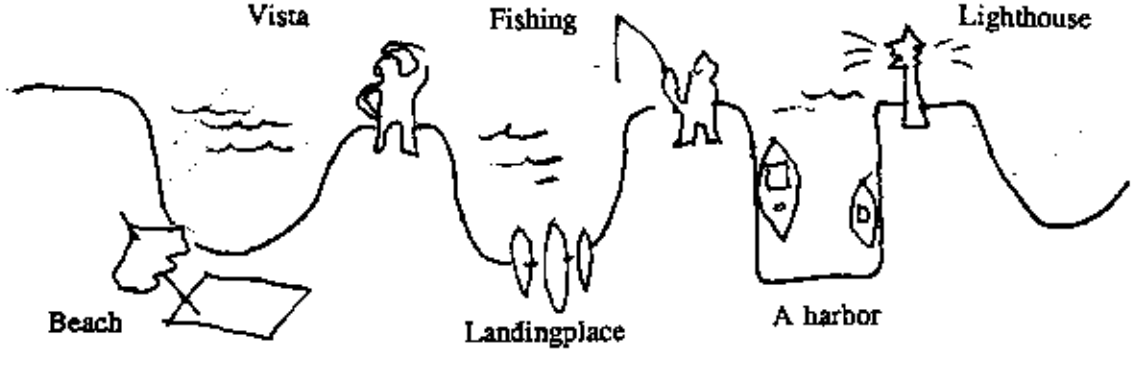
COMPLEMENTARY PAIR. Pairs that are functionally important to each other. Examples: male/female, fishing harbor/fish producing area, residential area/recreational area. Frequently contemporary land-use plans fail to recognize and act upon this principle.

COMPLEMENTARITY (THE GENERAL PRINCIPLE) Explains the nature of, and the interrelation between COMPLEMENTARY PAIRS. Such pairs form a natural unit, a natural WHOLENESS.

Complementarity has not been fully explained in contemporary science, but knowledge about it has been advanced in quantum physics, color theory, ecology and neurological science.

COMPLEMENTARITY (PRINCIPLE III--ITS FUNCTIONS). If two adjacent areas have been given a character and functions that make them a COMPLEMENTARY PAIR, then more activity takes place between the two compared to places with a less match of such features.

CONCAVITY/CONVEXITY (PRINCIPLE II--ITS FUNCTIONING). An interface, a shoreline, between two adjacent areas can be formed in such a way that it contains concavities and convexities. Some of the ACTIVITIES that are naturally linked to concavities and convexities are INTERRELATING ACTIVITIES between an urban and a water area. Some such activities form a center which is called an EXCHANGER.



CONNECTIONS. Our present paradigm of dissection disregards networks that relate and connect the elements of our lives and our environment. A science of physical connections is now being developed within such fields as ergonomics and interface-design in engineering.

CORE (PRINCIPLE IV--ITS FUNCTIONS). The presence of cores (islands, lakes, etc.) in an interface-zone is essential for the existence of specific ecological systems, and human and biological ACTIVITIES linked to them (see LINKS). Some of these activities form a connection between land- and water-areas as this thesis demonstrates. See INTERRELATING ACTIVITIES.

INTERFACE (OR INTERPHASE). A new double-awareness word that signifies the relation of two areas (opposed to the single-awareness word "edge" that only refers to one of the areas). This term "interface" also replaces another word "boundary" that defines a line between areas as a separation. The word "interface" on the other hand, is valuefree, i.e. an interface can be defined as an area that could both separate and/or connect the two areas.

INTEGRATION. From Latin: integrare: to make whole. Integration is thus an act of incorporating and connecting all the features necessary to produce a WHOLENESS.

INTERRELATING ACTIVITIES. Functional activities that create two-way connections between areas. These activities are somewhat different within the four form principles; for examples see: CIRCLE, CONCAVE/CONVEX, COMPLEMENTARITY and CORE. Also, see the definitions of the terms: ACTIVITIES, EXCHANGER, and CHANNELS.

INTERRELATION. A term that incorporates the double-awareness that relations go both ways (replaces the word contact). Example: a farm on an island has a relation to

buyers of agricultural products on the mainland, and the buyers have a relation to the farm, i.e. an interrelation exists.

LINKS (BETWEEN ECOLOGICAL AND MORPHOLOGICAL FORMS). Distinctive morphological elements in a landscape usually have matching distinctive ecological systems. Of the principles discussed in this dissertation CONCAVITY/CONVEXITY (II) and CORES (IV) have the most distinctive links between form and an ecological system. For example--cores of land in water have island or rock ecologies, and cores of water in land have pool, lake or lagoon ecologies.

ORDER. A regular disposition, based on a chosen methodoligcal scheme. Complementary order is based on the belief that everything in the world comes in pairs.

PRESENCE. A term used in this thesis to denote the existence of functional or morphological features connected to the four principles.

RICHNESS (IN BIOLOGICAL FUNCTIONS). When used in connection with the biological realm the term richness is defined as a function of the following ecosystem variables:

1) the diversity (number of species),
2) quantity (amount of biomass or individuals), and
3) system health.

RICHNESS (IN HUMAN FUNCTIONS). When used in connection with the human ACTIVITIES, the term richness is defined as a function of:

1) the diversity of activities (i.e. the number of different activities),

2) quantity (the total level of activity)

3) the extent to which the activity builds on the complentary relationships between land water.

RICHNESS (MORPHOLOGICAL). Morphological richness is a term that is defined in different ways for each of the four form-principles (see the theory section for an exact definition). The term PRESENCE merely indicates whether or not a given form-element exists in an area. The term RICHNESS indicates the external and/or intensity of the form-elements' presence.

WHOLENESS (IN ECOSYSTEMS). Denotes the presence of the elements, conditions and links necessary for the full and healthy functioning of the given ecosystem.

WHOLENESS (IN PHYSICAL PLANNING). Denotes the presence of the elements necessary for the full, healthy and integrated functioning of the COMPLEMENTARY PAIR (such as a house and a garden, or an urban area and an adjacent water area).