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STUDENT PUBLICATIONS OF THE SCHOOL OF DESIGN

J. Robert Oppenheimer

PROSPECTS IN THE ARTS AND SCIENCES

The following is a transcript of a talk by Dr. J. Robert Oppenheimer, Director of the Institute for Advanced Study, Princeton, New Jersey. It was part of the Columbia University Bicentennial lecture series, "Man's Right to Knowledge" and was broadcast over the CBS network December 26, 1954.

The words "prospects in the arts and sciences" mean two quite different things to me. One is prophecy: What will the scientists discover and the painters paint, what new forms will alter music, what parts of experience will newly yield to objective description? The other meaning is that of a view: What do we see when we look at the world today and compare it with the past? I am not a prophet; and I cannot very well speak to the first subject, though in many ways I should like to. I shall try to speak to the second, because there are some features of this view which seem to me so remarkable, so new and so arresting, that it may be worth turning our eyes to them; it may even help us to create and shape the future better, though we cannot foretell it.

In the arts and in the sciences, it would be good to be a prophet. It would be a delight to know the future. I had thought for a while of my own field of physics and of those nearest to it in the natural sciences. It would not be too hard to outline the questions which natural scientists today are asking themselves and trying to answer. What, we ask in physics, is matter, what is it made of, how does it behave when it is more and more violently atomized, when we try to pound out of the stuff around us the ingredients which only violence creates and makes manifest? What, the chemists ask, are those special features of nucleic acids and proteins which make life possible and give it its characteristic endurance and mutability? What subtle chemistry, what arrangements, what reactions and controls make the cells of living organisms differentiate so that they may perform functions as oddly diverse as transmitting information throughout our nervous systems or covering our heads with hair? What happens in the brain to make a record of the past, to hide it from consciousness, to make it accessible to recall? What are the physical features which make consciousness possible?

All history teaches us that these questions that we think the pressing ones will be transmuted before they are answered, that they will be replaced by others, and that the very process of discovery will shatter the concepts that we today use to describe our puzzlement.

It is true that there are some who profess to see in matters of culture, in matters precisely of the arts and sciences, a certain macro-historical pattern, a grand system of laws which determines the course of civilization and gives a kind of inevitable quality to the unfolding of the future. They would, for instance, see the radical, formal experimentation which characterized the music of the last half-century as an inevitable consequence of the immense flowering and enrichment of natural science; they would see a necessary order in the fact that innovation in music precedes that in painting and that in turn in poetry, and point to this sequence in older cultures. They would attribute the formal experimentation of the arts to the dissolution, in an industrial and technical society, of authority, of secular, political authority, and of the catholic authority of the church. They are thus armed to predict the future. But this, I fear, is not my dish.

If a prospect is not a prophecy, it is a view. What does the world of the arts and sciences look like? There are two ways of looking at it: One is the view of the traveler, going by horse or foot, from village to village to town, staying in each to talk with those who live there and to gather something of the quality of its life. This is the intimate view, partial, somewhat accidental, limited by the limited life and strength and curiosity of the traveler, but intimate and human, in a human compass. The other is the vast view, showing the earth with its fields and towns and valleys as they appear to a camera carried in a high altitude rocket. In one sense this prospect will be more complete; one will see all branches of knowledge, one will see all the arts, one will see them as part of the vastness and complication of the whole of human life on earth. But one will miss a great deal; the beauty and warmth of human life will largely be gone from that prospect.

It is in this vast high altitude survey that one sees the general surprising quantitative features that distinguish our time. This is where the listings of science and endowments and laboratories and books published show up; this is where we learn that more people are engaged in scientific research today than ever before, that the Soviet world and the free world are running neck and neck in the training of scientists, that more books are published per capita in England than in the United States, that the social sciences are pursued actively in America, Scandinavia, and England, that there are more people who hear the great music of the past, and more music composed and more paintings painted. This is where we learn that the arts and sciences are flourishing. This great map, showing the world from afar and almost as to a stranger, would show more: It would show the immense diversity of culture and life, diversity in place and tradition for the first time clearly

manifest on a world-wide scale, diversity in technique and language, separating science from science and art from art, and all of one from all of the other. This great map, world-wide, culture-wide, remote, has some odd features. There are innumerable villages. Between the villages there appear to be almost no paths discernible from this high altitude. Here and there passing near a village, sometimes through its heart, there will be a superhighway, along which windy traffic moves at enormous speed. The superhighways seem to have little connection with villages, starting anywhere, ending anywhere, and sometimes appearing almost by design to disrupt the quiet of the village. This view gives us no sense of order or of unity. To find these we must visit the villages, the quiet, busy places, the laboratories and studies and studios. We must see the paths that are barely discernible; we must understand the superhighways, and their dangers.

In the natural sciences these are and have been and are likely to continue to be heroic days. Discovery follows discovery, each both raising and answering questions, each ending a long search, and each providing the new instruments for a new search. There are radical ways of thinking unfamiliar to common sense and connected with it by decades or centuries of increasingly specialized and unfamiliar experience. There are lessons of how limited, for all its variety, the common experience of man has been with regard to natural phenomena, and hints and analogies as to how limited may be his experience with man. Every new finding is a part of the instrument kit of the sciences for further investigation and for penetrating into new fields. Discoveries of knowledge fructify technology and the practical arts, and these in turn pay back refined techniques, new possibilities of observation and experiment.

In any science there is harmony between practitioners. A man may work as an individual, learning of what his colleagues do through reading or conversation; he may be working as a member of a group on problems whose technical equipment is too massive for individual effort. But whether he is a part of a team or solitary in his own study, he, as a professional, is a member of a community. His colleagues in his own branch of science will be grateful to him for the inventive or creative thoughts he has, will welcome his criticism. His world and work will be objectively communicable; and he will be quite sure that if there is error in it, that error will not long be undetected. In his own line of work he lives in a community where common understanding combines with common purpose and interest to bind men together both in freedom and in co-operation.

This experience will make him acutely aware of how limited, how inadequate, how precious is this condition of his life; for in his relations with a wider society, there will be neither the sense of community nor of objective understanding. He will sometimes find, in returning to practical undertakings, some sense of community with men who are not expert in his science, with other scientists whose work is remote from his,

and with men of action and men of art. The frontiers of science are separated now by long years of study, by specialized vocabularies, arts, techniques, and knowledge from the common heritage even of a most civilized society; and anyone working at the frontier of such science is in that sense a very long way from home, a long way too from the practical arts that were its matrix and origin, as indeed they were of what we today call art.

The specialization of science is an inevitable accompaniment of progress; yet it is full of dangers, and it is cruelly wasteful, since so much that is beautiful and enlightening is cut off from most of the world. Thus it is proper to the role of the scientist that he not merely find new truth and communicate it to his fellows, but that he teach, that he try to bring the most honest and intelligible account of new knowledge to all who will try to learn. This is one reason—it is the decisive organic reason—why scientists belong in universities. It is one reason why the patronage of science by and through universities is its most proper form; for it is here, in teaching, in the association of scholars, and in the friendships of teachers and taught, of men who by profession must themselves be both teachers and taught, that the narrowness of scientific life can best be moderated, and that the analogies, insights, and harmonies of scientific discovery can find their way into the wider life of man.

In the situation of the artist today there are both analogies to and differences from that of the scientist; but it is the differences which are the most striking, and which raise the problems that touch most on the evil of our day. For the artist it is not enough that he communicate with others who are expert in his own art. Their fellowship, their understanding, and their appreciation may encourage him; but that is not the end of his work, nor its nature. The artist depends on a common sensibility and culture, on a common meaning of symbols, on a community of experience and common ways of describing and interpreting it. He need not write for everyone or paint or play for everyone. But his audience must be man; it must be man, and not a specialized set of experts among his fellows. Today that is very difficult. Often the artist has an aching sense of great loneliness, for the community to which he addresses himself is largely not there; the traditions and the culture, the symbols and the history, the myths and the common experience, which it is his function to illuminate, to harmonize, and to portray, have been dissolved in a changing world.

There is, it is true, an artificial audience maintained to moderate between the artist and the world for which he works: the audience of the professional critics, popularizers, and advertisers of art. But though, as does the popularizer and promoter of science, the critic fulfills a necessary present function and introduces some order and some communication between the artist and the world, he cannot add to the intimacy and the directness and the depth with which the artist addresses his fellow men.

To the artist's loneliness there is a complementary great and terrible barrenness in the lives of men. They are deprived of the illumination, the light and tenderness and insight of an intelligible interpretation, in contemporary terms, of the sorrows and wonders and gaieties and follies of man's life. This may be in part offset, and is, by the great growth of technical means for making the art of the past available. But these provide a record of past intimacies between art and life; even when they are applied to the writing and painting and composing of the day, they do not bridge the gulf between a society, too vast and too disordered, and the artist trying to give meaning and beauty to its parts.

In an important sense this world of ours is a new world, in which the unity of knowledge, the nature of human communities, the order of society, the order of ideas, the very notions of society and culture have changed and will not return to what they have been in the past. What is new is new not because it has never been there before, but because it has changed in quality. One thing that is new is the prevalence of newness, the changing scale and scope of change itself, so that the world alters as we walk in it, so that the years of man's life measure not some small growth or rearrangement or moderation of what he learned in childhood, but a great upheaval. What is new is that in one generation our knowledge of the natural world engulfs, upsets, and complements all knowledge of the natural world before. The techniques, among which and by which we live, multiply and ramify, so that the whole world is bound together by communication, blocked here and there by the immense synapses of political tyranny. The global quality of the world is new: our knowledge of and sympathy with remote and diverse peoples, our involvement with them in practical terms, and our commitment to them in terms of brotherhood. What is new in the world is the massive character of the dissolution and corruption of authority, in belief, in ritual, and in temporal order. Yet this is the world that we have come to live in. The very difficulties which it presents derive from growth in understanding, in skill, in power. To assail the changes that have unmoored us from the past is futile, and in a deep sense, I think, it is wicked. We need to recognize the change and learn what resources we have.

Again I will turn to the schools and, as their end and as their center, the universities. For the problem of the scientist is in this respect not different from that of the artist or of the historian. He needs to be a part of the community, and the community can only with loss and peril be without him. Thus it is with a sense of interest and hope that we see a growing recognition that the creative artist is a proper charge on the university, and the university a proper home for him; that a composer or a poet or a playwright or painter needs the toleration, understanding, the rather local and parochial patronage that a university can give; and that this will protect him from the tyranny of man's communication and professional promotion. For here there is an honest chance that what the artist has of insight and of beauty will take root in the community, and that some intimacy and some human bonds can mark his relations with his patrons. For a university rightly and inherently is a place where the individual man can form new syntheses, where the accidents of friendship and association can open a man's eyes to a part of science or art which he had not known before, where parts of human life, remote and perhaps superficially incompatible, can find in men their harmony and their synthesis.

These then, in rough and far too general words, are some of the things we see as we walk through the villages of the arts and of the sciences and notice how thin are the paths that lead from one to another, and how little in terms of human understanding and pleasure the work of the villages comes to be shared outside.

The superhighways do not help. They are the mass media—from the loud speakers in the deserts of Asia Minor and the cities of Communist China to the organized professional theatre of Broadway. They are the purveyors of art and science and culture for the millions upon millions—the promoters who represent the arts and sciences to humanity and who represent humanity to the arts and sciences; they are the means by which we are reminded of the famine in remote places or of war or trouble or change; they are the means by which this great earth and its peoples have become one to one another, the means by which the news of discovery or honor and the stories and songs of today travel and resound throughout the world. But they are also the means by which the true human community, the man knowing man, the neighbor understanding neighbor, the school boy learning a poem, the women dancing, the individual curiosity, the individual sense of beauty are being blown dry and issueless, the means by which the passivity of the disengaged spectator presents to the man of art and science the bleak face of unhumanity.

For the truth is that this is indeed, inevitably and increasingly, an open and, inevitably and increasingly, an eclectic world. We know too much for one man to know much, we live too variously to live as one. Our histories and traditions—the very means of interpreting life—are both bonds and barriers among us. Our knowledge separates as well as it unites; our orders disintegrate as well as bind; our art brings us together and sets us apart. The artist's loneliness, the scholar despairing, because no one will any longer trouble to learn what he can teach, the narrowness of the scientist—these are not unnatural insignia in this great time of change.

For what is asked of us is not easy. The openness of this world derives its character from the irreversibility of learning; what is once learned is part of human life. We cannot close our minds to discovery, we cannot stop our ears so that the voices of far-off and strange

people can no longer reach them. The great cultures of the East cannot be walled off from ours by impassible seas and defects of understanding based on ignorance and unfamiliarity. Neither our integrity as men of learning nor our humanity allows that. In this open world, what is there any man may try to learn.

This is no new problem. There has always been more to know than one man could know; there have always been modes of feeling that could not move the same heart; there have always been deeply held beliefs that could not be composed into a synthetic union. Yet never before today has the diversity, the complexity, the richness so clearly defied hierachial order and simplification, never before have we had to understand the complementary, mutually not compatible ways of life and recognize choice between them as the only course of freedom. Never before today has the integrity of the intimate, the detailed, the true art, the integrity of craftsmanship and the preservation of the familiar, of the humorous and the beautiful stood in more massive contrast to the vastness of life, the greatness of the globe, the otherness of people, the otherness of ways, and the all-encompassing dark.

This is a world in which each of us, knowing his limitations, knowing the evils of superficiality and the terrors of fatigue, will have to cling to what is close to him, to what he knows, to what he can do, to his friends and his tradition and his love, lest he be dissolved in a universal confusion and know nothing and love nothing. It is at the same time a world in which none of us can find hieratic prescription or general sanction for any ignorance, any insensitivity, any indifference. When a friend tells us of a new discovery we may not understand, we may not be able to listen without jeopardizing the work that is ours and closer to us; but we cannot find in a book or canon—and we should not seek—grounds for hallowing our ignorance. If a man tells us that he sees differently than we or that he finds beautiful what we find ugly, we may have to leave the room, from fatigue or trouble; but that is our weakness and our default. If we must live with a perpetual sense that the world and the men in it are greater than we and too much for us, let it be the measure of our virtue that we know this and seek no comfort. Above all let us not proclaim that the limits of our powers correspond to some special wisdom in our choice of life, of learning, or of beauty.

This balance, this perpetual, precarious impossible balance between the infinitely open and the intimate, this time—our twentieth century—has been long in coming; but it has come. It is, I think, for us and our children, our only way.

This is for all men. For the artist and for the scientist there is a special problem and a special hope, for in their extraordinarily different ways, in their lives that have increasingly divergent character, there is still a sensed bond, a sensed analogy. Both the man of

science and the man of art live always at the edge of mystery, surrounded by it; both always, as the measure of their creation, have had to do with the harmonization of what is new with what is familiar, with the balance between novelty and synthesis, with the struggle to make partial order in total chaos. They can, in their work and in their lives, help themselves, help one another, and help all men. They can make the paths that connect the villages of arts and sciences with each other and with the world at large the multiple, varied, precious bonds of a true and world-wide community.

This cannot be an easy life. We shall have a rugged time of it to keep our minds open and to keep them deep, to keep our sense of beauty and our ability to make it, and our occasional ability to see it in places remote and strange and unfamiliar; we shall have a rugged time of it, all of us, in keeping these gardens in our villages, in keeping open the manifold, intricate, casual paths, to keep these flourishing in a great, open, windy world; but this, as I see it, is the condition of man; and in this condition we can help, because we can love, one another.

Robert Le Ricolais

TOPOLOGY AND ARCHITECTURE

Le Ricolais is a French structural engineer, formerly structural consultant to fifth year class of the School of Design.

"How architecture, which deals with connections, could ignore topology, which by itself is the science of connectivity".
Extract from a letter of Professor Cyril Stanley Smith, Director of Chicago Institute of Metals.

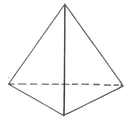


Fig. 1

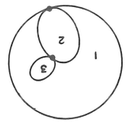


Fig. 2

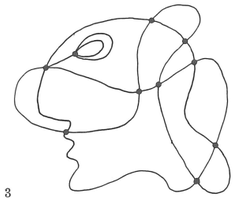


Fig. 3

The key to topological analysis is given by Euler's Law
In 3 D space where:
P is the number of faces
E is the number of edges
C is the number of apices or corners
$P - E + C = 2$
In a tetrahedron for an example (Fig. 1)
$P = 4, E = 6, C = 4$, i.e. $4 - 6 + 4 = 2$

In 2 dimension space where:
P is the number of polygons
E is the number of edges
C is the number of joints
$P - E + C = 1$
In Fig. (2) we have
$P = 3, E = 4, C = 2$, i.e. $3 - 4 + 2 = 1$
Fig. (3)
$P = 12$
$E = 21$
$C = 10$
$12 - 21 + 10 = 1$

Note: This figure is inspired from a study by Prof. C. S. Smith, of the Chicago Institute of Metals, on the importance of topology in metallurgical researches.

FUNDAMENTALS OF TOPOLOGY: THE DUAL CONCEPT . . .

Its object:

A new mathematical thinking where shapes and magnitudes of configurations are of *No Importance.*

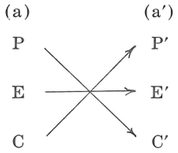
For the topologist a square = circle = triangle. A sphere = tetrahedron = cube.

The true important knowledge, in variation of shapes, is to detect what remains constant during this transformation process.

This explains why topology has been called the rubber geometry.

A simple application of this principle is as follows since: $P - E + C = 1$

If *E is constant,* we may permute P with C (and C with P) without changing the sum and write:



Where:
$E = E'$
$P = C'$
$C = P'$

The configuration (a^1) becomes analogous to an optical "image" of (a).

This elementary approach will enable us not only to understand the truly admirable variety of solutions obtained through combinatorial topology, but will also yield a powerful tool for circulatory problems and partition situation, the first problem being the image of the other.

We have first to get acquainted with the notion of group.

PROBLEM

How many configurations answer to the condition yielded by let us say:

Fig. a

$P = 2, E = 3, C = 2$?

Intuitively we can find configurations, (a) (b) (c)

First question—How many figures like (a), (b), and (c) can we draw?

This is an easy problem if we take into consideration the number of branches radiating from each joint and noting that each segment has two branches, *i.e.*, number of branches = 2E.

Fig. b

In Fig. (a) $2E = 6$, which number is to remain constant, thus it appears that the total number of combinations amounts to how many ways we can put (2E) = 6 as the sum of two integers (2 joints). This gives

$$2E = 6 = 3 + 3$$
$$= 2 + 4$$
$$= 1 + 5$$

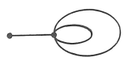
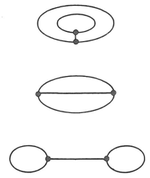


Fig. c



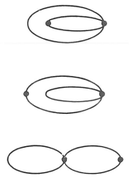
(a) 6=3+3

Are we certain now that (a), (b), and (c) are the only possible solutions?

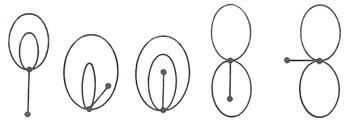
Intuitively we would say no. We will now give the demonstration.
The total number of combinatorial diagrams is not 3, but 11 combinations and these can be tabulated as follows:

First Alternative (enveloped config.) Noting that the position of the 1 branch joint can have only P + 1 situations

Second Alternative
The 1 branch joint (avoiding repetitions) has P situations
Total 2P + 1 = 5 comb.
The 2 branch joint has one choice in the 2 external loops 2 choices in the internal loop
i.e. 3 comb.
According to the situation of the loops 3 comb.
Total: 5 + 3 + 3 = 11



(b) 6=2+4



(c) 6=1+5

TOPOLOGY AND TRAFFIC PROBLEMS . . .

Amongst the many applications of topology in urban traffic we will investigate the maximum numbers of roads intersecting, should intersections have more than 4 branches. In an important underground project for Paris we have figured the time loss in an 8 ways crossing on the same level! With the simplifying assumption of equal load in all directions taking this junction in 4 phases (opposed ways), let n be the number of phases. For a probability P of crossing the intersection in a given time, the probability of each phase should be:

$$P^{1-n}$$

In order to have an idea, let us presume that in no peak load, the length of a phase is 30″—in order to obtain let us say 75% overall efficiency (this one being defined as the ratio between effective and theoretical output) the time taken for the crossing is:

$$30'' \times 4 \times 1.25 = 150''$$

This overall efficiency yields for each phase an efficiency of:

$$\sqrt[4]{0.75} = 0.93$$

Supposing now for two obvious reasons: (a) overcrowded pavements, (b) lower speed to avoid points of intersections, that the efficiency of each phase fall to 50%—overall efficiency becomes $\sqrt[4]{0.50} = 0.0625$
The time taken for crossing the junction becomes:

$$150''/0.0625 = 37'$$

which is of course unacceptable. This shows that, as it is commonly known, the number of branches should be as small as possible, 3 or 4 branches maximum. This deplorable solution of multiroads intersection is obviously proved by the Paris Place De L'Etoile where 12 avenues converge. And this despite the considerable diameter of the plaza and adjoining avenues.

The theory of combinatorial arrangements as devised by Mr. Faure would be too long and a little abstruse for average readers, yet its object is simple and the problem runs as follows:

"How many ways of distributing s balls into n compartments with a minimum of P balls per compartment?"

It is very probable that Euler, Gauss, or others have solved it but Faure's treatment is of a peculiar elegance. His method can be outlined as follows — Problem: How many ways of stowing 12 balls in 4 compartments with the condition of a minimum of 2 balls per compartment?

The operations may be tabulated as follows:

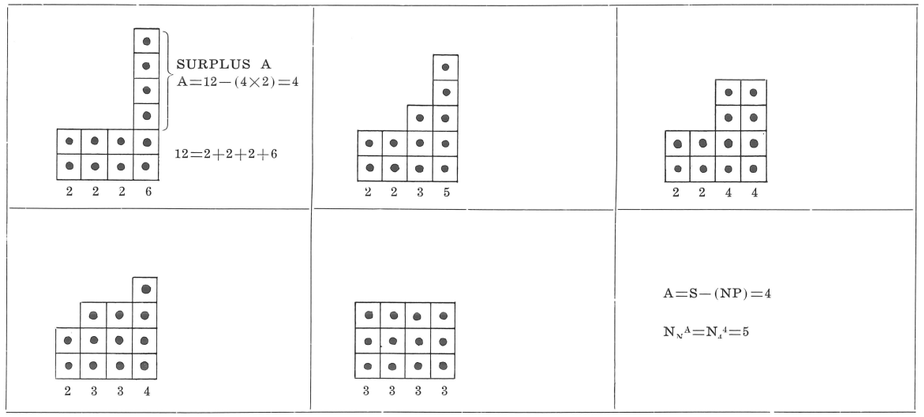


Table 1 will supply the solutions for simple problems. For instance: In how many ways can we combine 2E = S = 20 in sum of let us say 4 integers (4 joints) with 2 as a minimum (i.e. 2 branches joints).

We calculate surplus

$$a = s - np = 20 - 4 \times 2 = 12$$

We take A = 12 on the first line, travel downward to N_4 and read $N_4{}^{12} = 34$ combinations.

Remark: This table gives also the partition function P(n) which is how many ways of writing n as the sum of integers.

$$P(n) = N_n{}^n$$

On Table 1 (only from 1 to 5). Example for n = 4, P(n) = 5 for P(5) = 7

TABLE I—$N_r^a - (A = S - np)$

FROM n = 7 to n = 5

a = surplus
s = sum
n = number of terms
p = minimum number

A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
N_2^a	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11
N_3^{a-3}	—	—	1	1	2	3	4	5	7	8	10	12	14	16	19	21	24	27	30	30
N_3^a	1	2	3	4	5	7	8	10	12	14	16	19	21	24	27	30	33	37	40	44
N_4^{a-4}	—	—	—	1	1	2	3	5	6	9	11	15	18	22	27	34	39	46	54	64
N_4^a	1	2	3	5	6	9	11	13	18	23	27	34	39	46	54	64	72	83	94	105
N_5^{a-5}	—	—	—	—	1	1	2	3	5	7	10	13	18	23	30	37	47	57	69	84
N_5^a	1	2	3	5	7	10	13	18	23	30	37	47	57	69	84	101	119	140	163	189

NOTION OF QUALITATIVE SPACE . . .

To illustrate the importance of connections, let us compare orthogonal (a) versus hexagonal partition (b).

In (a) we realize that C is not directly connected to A. Of course some devices may be used to make possible such connection, but detrimental to simplicity and full efficiency of floor area, while in (b) all rooms are connected to A.

This shows that the quality of space is related to the maximum number of possible connections, together with the condition of minimum distance for all the possible displacements.

Such problems are found in electricity in the study of switching systems. Connections and contiguity play an important role in planning.

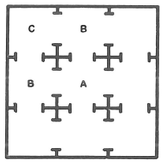


Fig. a

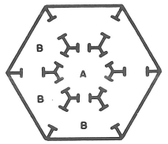


Fig. b

THE PARTITION PROBLEM

A distinction should be made between connections and circulations. If a space A and B are adjacent they can be connected through a door.

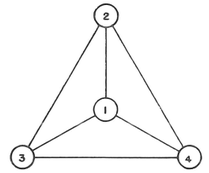
If A and B are connected by a corridor, circulation is involved.

Both connections and circulations will be schematized by a dynamic diagram, noting that circulations may be either differentiated or undifferentiated, but are as a rule uncommutative, which means that a given order is presumably adequate.

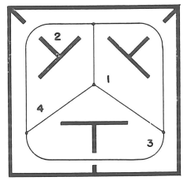
(a) What are all the possible partition diagrams fulfilling the conditions set by the dynamic diagram?

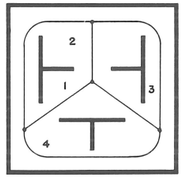
(b) What are amongst all solutions, the best one, fulfilling both the local specific requirements, together with the optimum circulatory diagram?

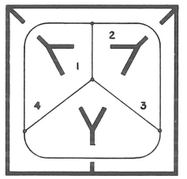
Let us for an example have the following dynamic diagram D connecting room 1 to 2, 3, 4; 2 being connected to 4 and 3, 3 to 2 and 4, 4 to 3 and 2.

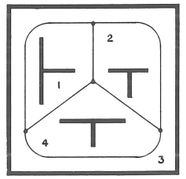


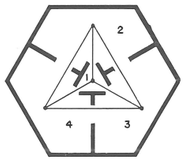
The situation diagrams may be of the following types, those being a few combinations amongst many others.











An intuitive analysis will show that both for shorter displacements and partition economy, the possible configuration (e) and (f) would give the best configuration plan.

To conclude:

From a given dynamic diagram a group of situation plans result—all dynamic above are said to be "homromorph" i.e., topologically equivalent, or having the same P, E and C.

After analysis of those, the best situation plan will be the one yielding the minimum displacement and the minimum length of partition for a given area.

PROBLEM OF GRID PATTERN IN TOWN PLANNING . . .

From a strictly theoretical point of view, triangular grid for town planning are of great interest (New Delhi) following closely the bee's line they induce shortest displacements from one point to the other.

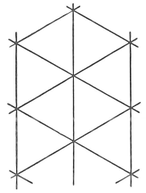


Fig. a

Unfortunately triangular grids increase intersection number, i.e., the number of connections between segments and this to a great extent, since for illimited areas the connection number is twice the number obtained with the orthogonal pattern. Thus the time gained in distance is lost by the time taken by the intersection stop.

The topological solution to alleviate this situation would be shown in (b), in the "star-triangle" system, which keeps only intersections of 2 roads and which increase the combinatorial potentiality of secondary roads of shortest length for a given area.

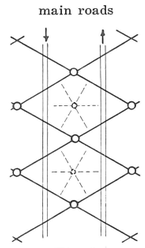


Fig. b

CONCLUSION

Our scientific knowledge of architecture is about as empirical as was the art of building before Maxwell and Cremona, founders of statics.

Truss stress diagrams and dynamic circulation diagrams are indeed using identical geometric relationship of reciprocal figures based on the same topological concept.

In its relationship with architecture, at least for problems of circulatory nature, topology plays not only a role on the economy of partitions, but a far more reaching consequence is to be foreseen in the economy of displacements, i.e. T I M E.

Drawings by staff of the publications of the School of Design.

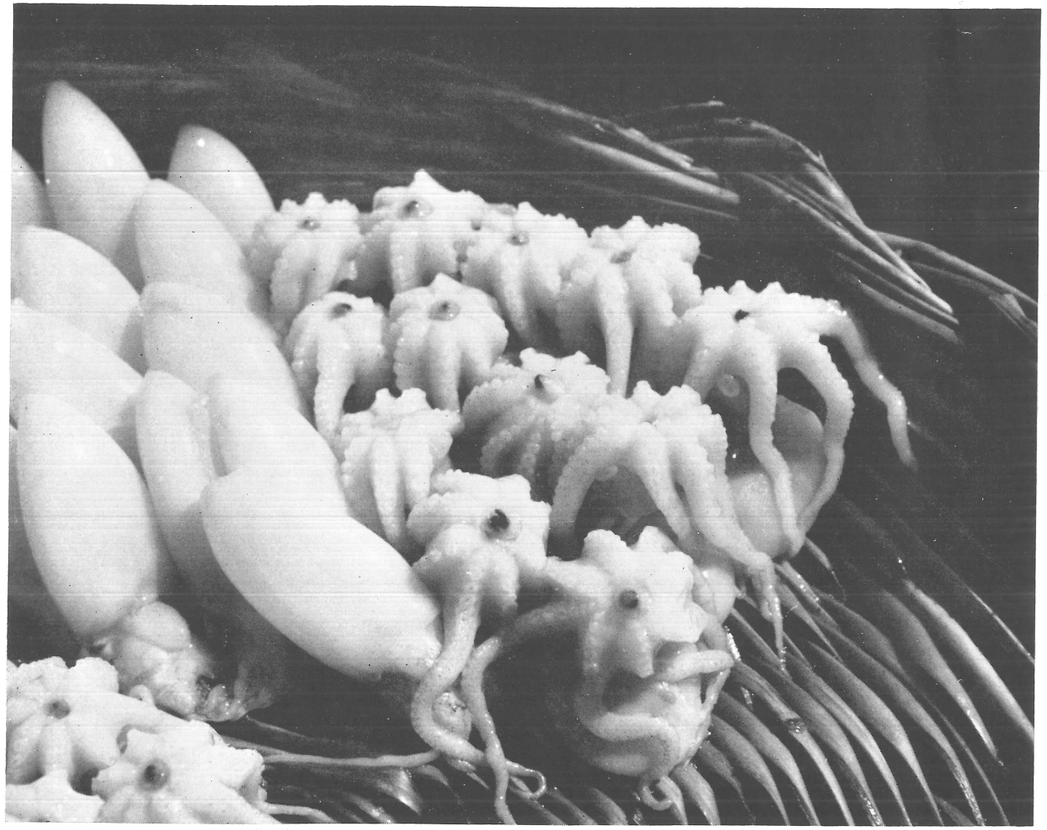
photography

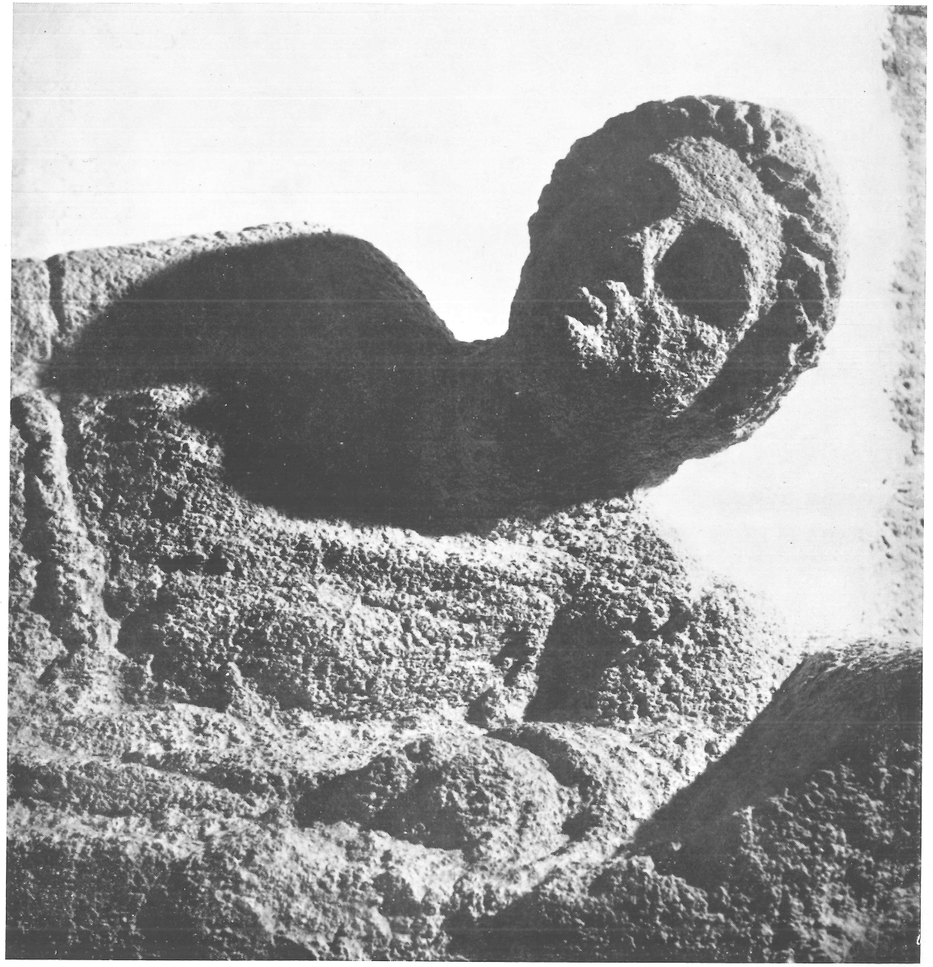
hilosophy of photography. But, in looking over the work you have selected to print, ıe coherence in the imagery which comes from a constant preoccupation with art

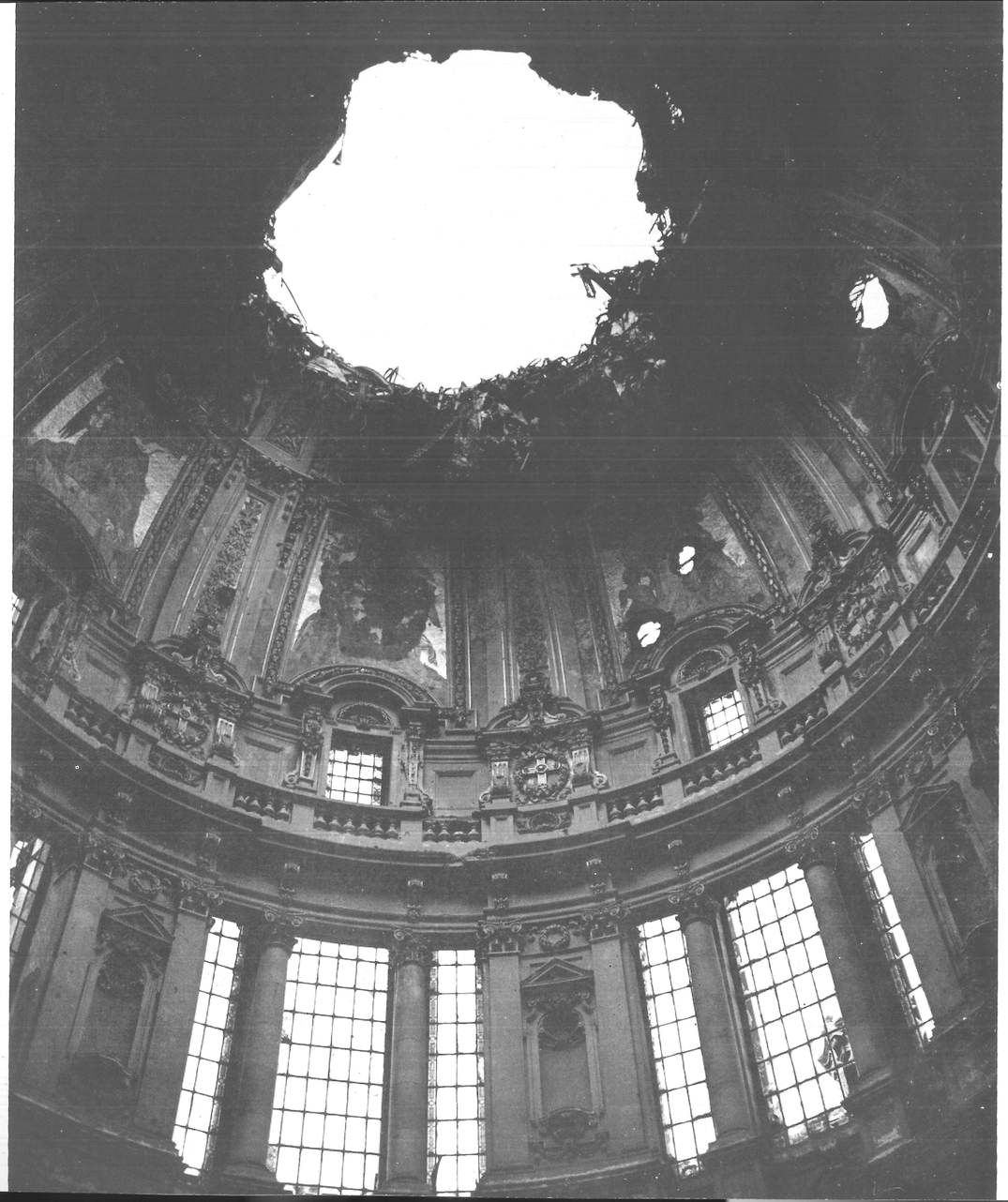
lucky. My work has brought me to Europe, the Middle East and North Africa and oint my camera at the great ruins of Europe. Some of the drama of history has nd may be seen in some of the pictures.

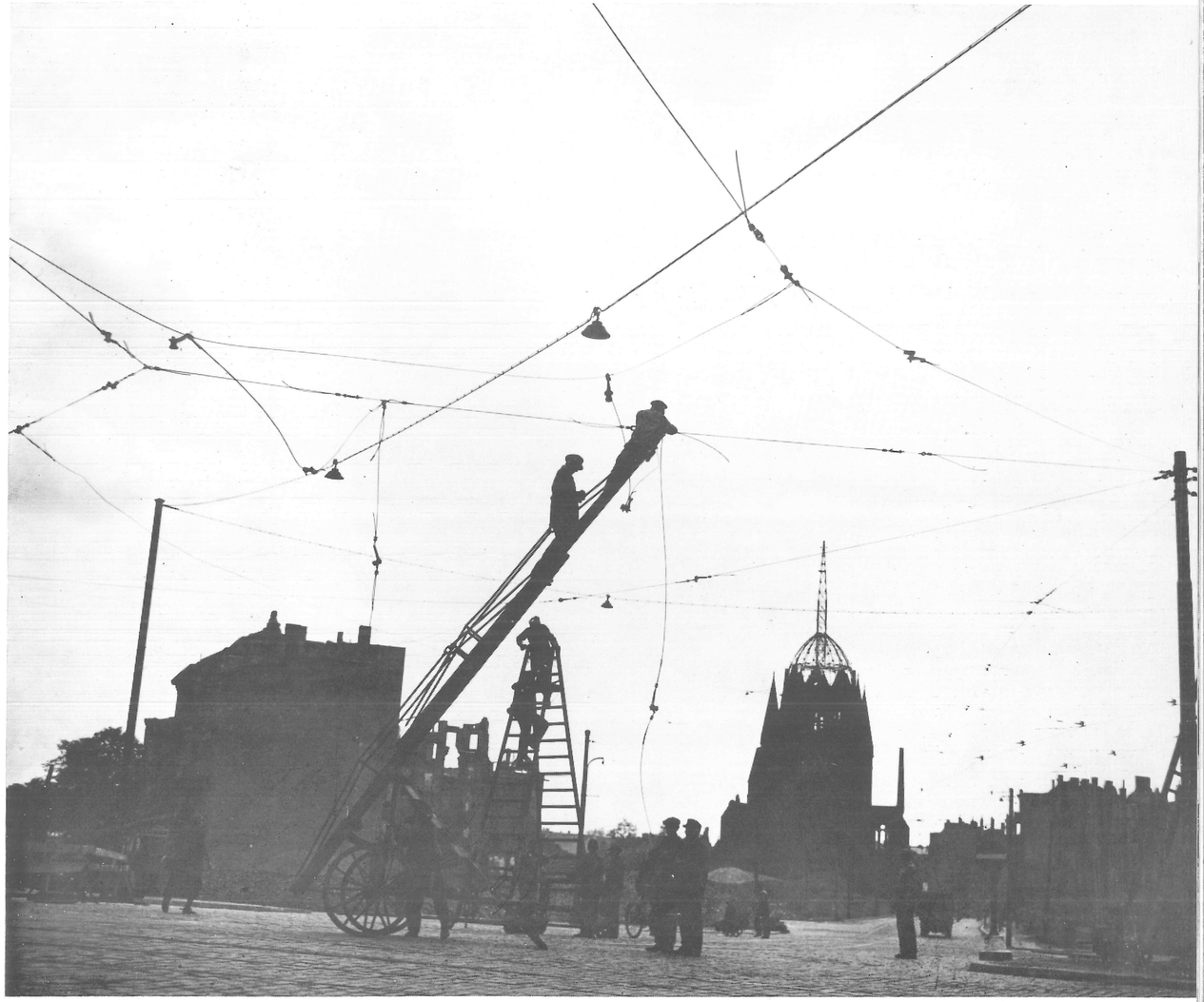
th objects and try to tell the big story by means of symbol. Sometimes a person o enters a photograph. But mostly I photograph objects as symbols.

Sam Rosenberg







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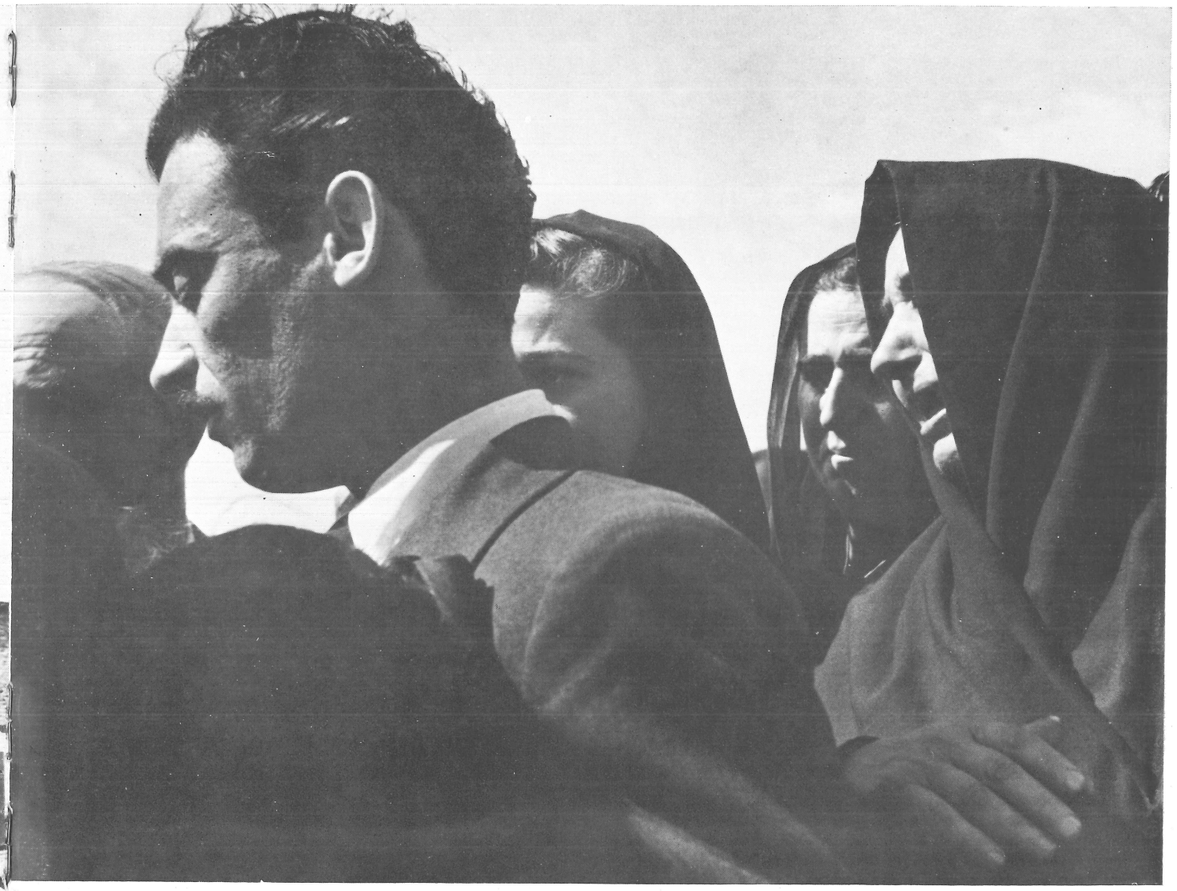

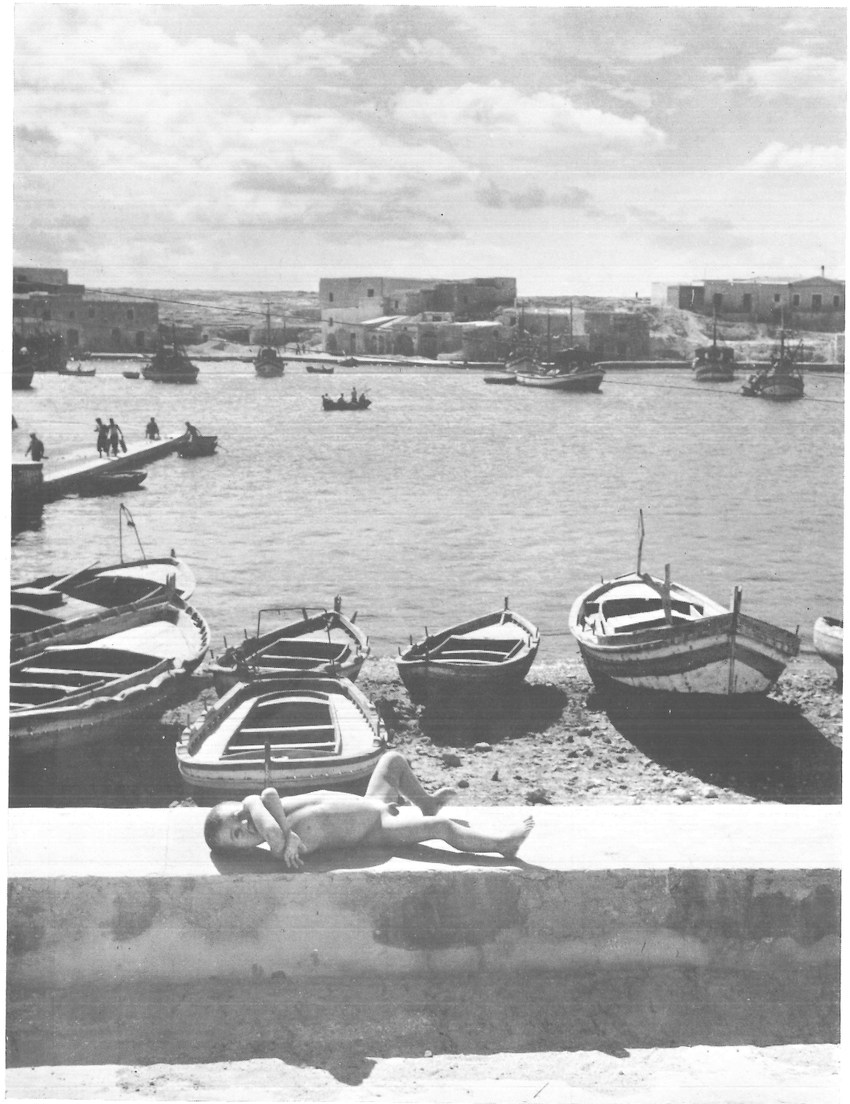

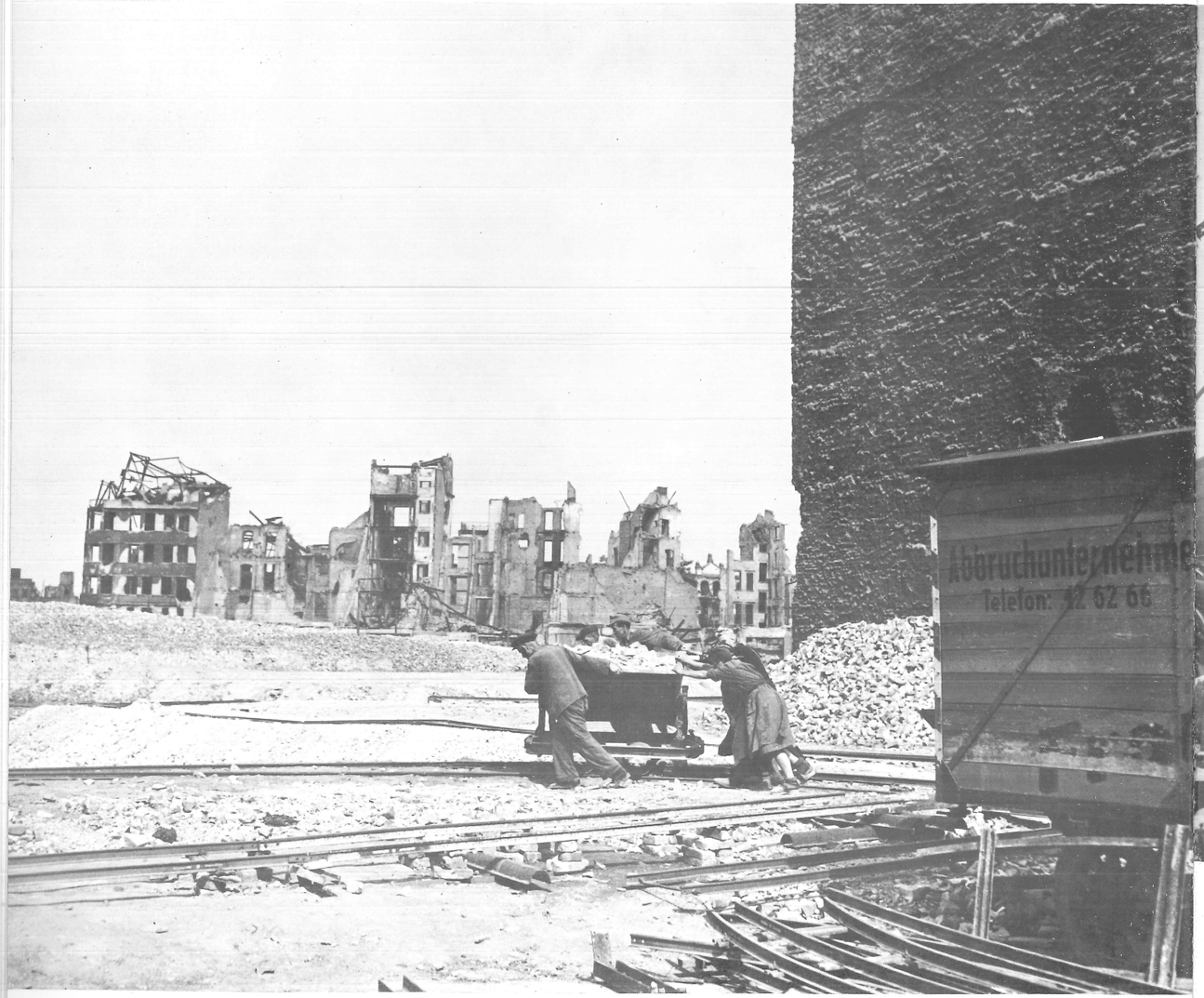
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Telefon: 12 62 66

Sam ROSENBERG: V-J Day.

PHOTOGRAPHS

1. CHINA FACTORY, GERMANY
2. SQUID
3. ETRUSCAN SCULPTURE
4. BERLIN CATHEDRAL 1946
5. BERLIN 1946
6. BERLIN 1946
7. FUNERAL SERVICE SARDINIA
8. ISLAND OF LAMPEDUSA
9. KAISER WILHELM I
10. RECONSTRUCTION, BERLIN
11. TWO BOYS, ITALY 1952
12. VJ DAY, U.S.A.

Sam Rosenberg is an associate professor of Design and teaches photography in the School of Design.

RURAL SURVEY

COLLABORATIVE PROBLEM

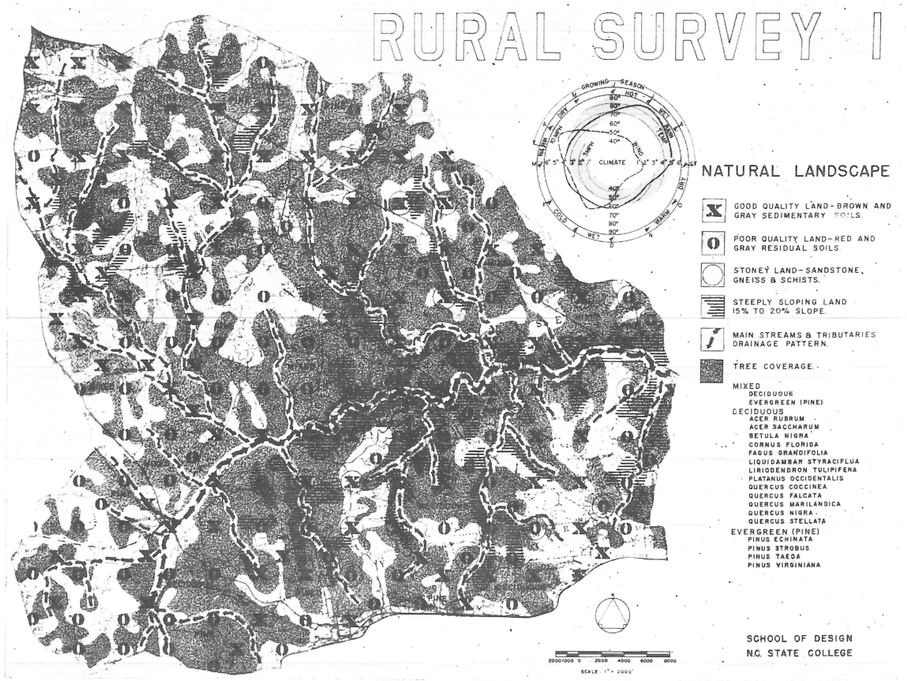
INTRODUCTION

The following study of an area of rural landscape was produced by a group of students at the School of Design, North Carolina State College, working during four weeks in the early part of 1955 under the direction of Mr. Brian Hackett, then visiting lecturer in landscape architecture. The purpose of the study was the evaluation of specific proposals for the development and design of a landscape area.

The area selected included approximately 80 square miles of the upper basin of Crabtree Creek lying west and northwest of Raleigh, North Carolina. The project was in no sense a completed scheme, rather it was a pilot study used to familiarize the students with the approach and techniques for dealing with the larger landscape area. Emphasis was on development for production based upon the indications present in the natural landscape.

The students working under Mr. Hackett on this study were: E. W. Avent, T. H. Barrows, W. T. Bradshaw, L. Bryan, B. Ellentuck, J. F. Ellis, B. W. Gary, J. F. Kluttz, K. J. Krantz, R. MacDonald, S. Mintz, R. Montgomery, A. B. Moore, D. J. Morton, H. L. Price. All were third and fourth year students from both architecture and landscape architecture departments.

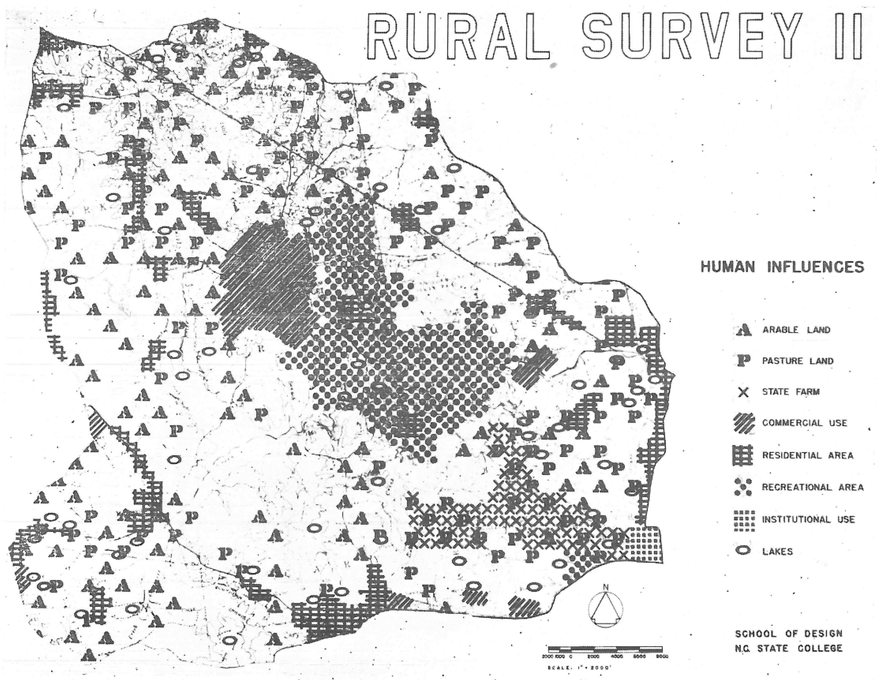
Following are reproduced the graphic exhibits produced during this project, and an edited version of the written report which is intended chiefly as explanation of the graphic work.



PART 1—SURVEY

To discover the maximum potentials of the site a survey was made of the elements that contributed significantly to its present form. This survey was divided into three studies: (1) the natural landscape, (2) man's influence on the landscape and (3) the various services and utilities existing in the area. The members of the project group were divided into three teams each responsible for one of these studies. The team members obtained their data largely from actual examination of the site: each individual being responsible for collecting the material for his team's work in a particular portion of the area.

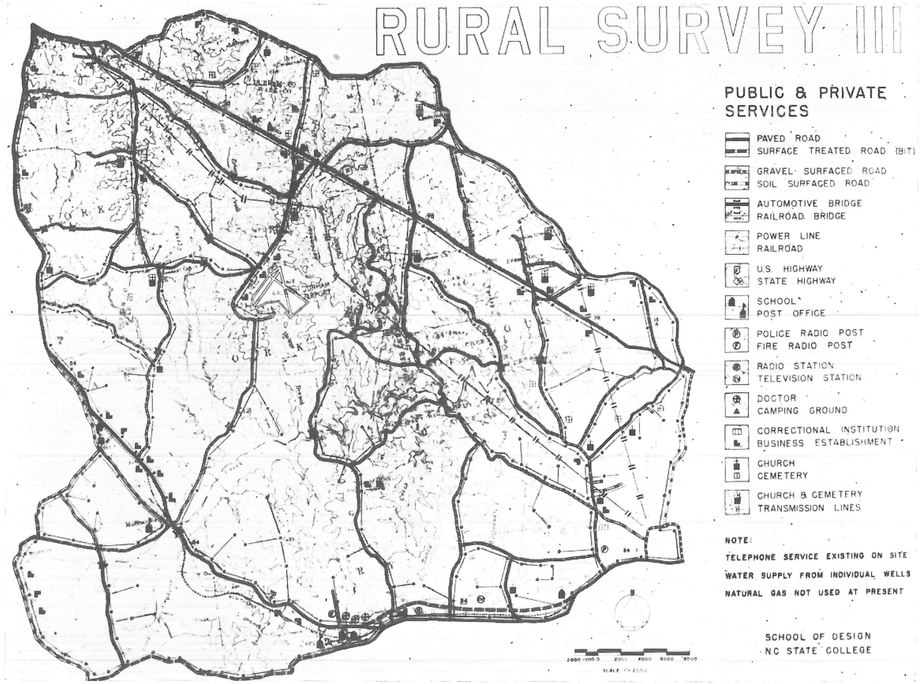
The first and most fundamental of these studies was the survey of the natural landscape presented on the panel titled RURAL SURVEY 1. Here is indicated land form, soil types, tree distribution, drainage system, and climatic conditions. The land ranges in elevation from 250 to 550 feet above sea level, with land form varying from flood plains to dry rocky uplands. Soil types vary widely, but on the survey panel are indicated only as good or poor. Good soil, including chiefly conguree silt, meadow and Iredell loams, and poorer soils, including cecil clay, Louisa clay loams and Rustian sandy-loam; are shown respectively by the symbols X and O. Stoney soils are indicated where the quality symbol is circled. Tree species and forest coverage were generalized by showing only areas of more than 50% ground coverage. These forested areas were broken into mixed, deciduous and evergreen types. Finally the climatic conditions prevailing on the site are presented diagrammatically with this natural landscape survey.



Rural Survey II panel deals in a general manner with man's influence upon the landscape. Here are drawn by various graphic means the patterns of man's transformation of the landscape. The great bulk of the area has been affected only by various agricultural uses. In relatively recent times a large area in the center of the site has been set aside for purely recreational use. Adjoining this is the large airport—marked commerical use on the Survey II panel serving this region. The predominant agricultural uses are about equally divided between livestock pasturage and arable land. This represents a recent change in emphasis with livestock becoming relatively more important. The manmade lakes are another recent evidence of the agricultural change as most were built to provide permanent water supplies in conjunction with pastures. For chiefly rural land the population density of this site is high and is marked by clusters of non-farm families dwelling throughout the area.

The final segment of the rural survey is entitled Public and Private Services. Here is presented a graphic census of the facilities and utilities that now exist on the site, and that form a basis for the more intensive uses of the land.

These three divisions of the survey are presented graphically in the proper location on the site on the three survey panels. This method of graphic presentation forced on the survey teams an automatic process of abstraction and generalization that was crucial to the later stages of the project.

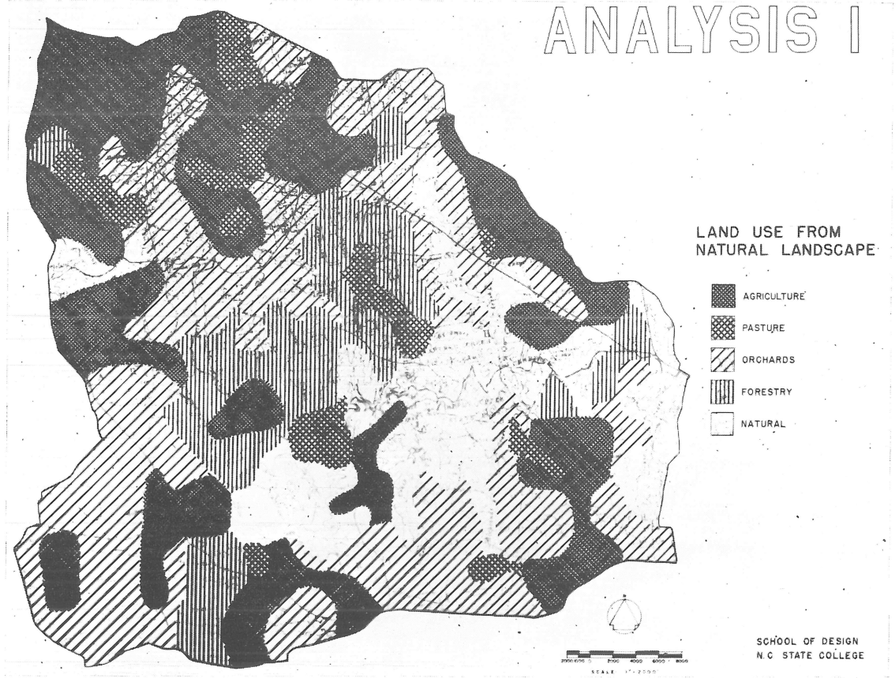


PART II—ANALYSIS

The second basic stage of the project began with analysis of the data obtained from the completed regional survey. This analysis was directed to the question of the future character of the region. Each of the three survey teams carried on a separate study of its aspect of the survey to determine ideal and possible trends in the landscape development.

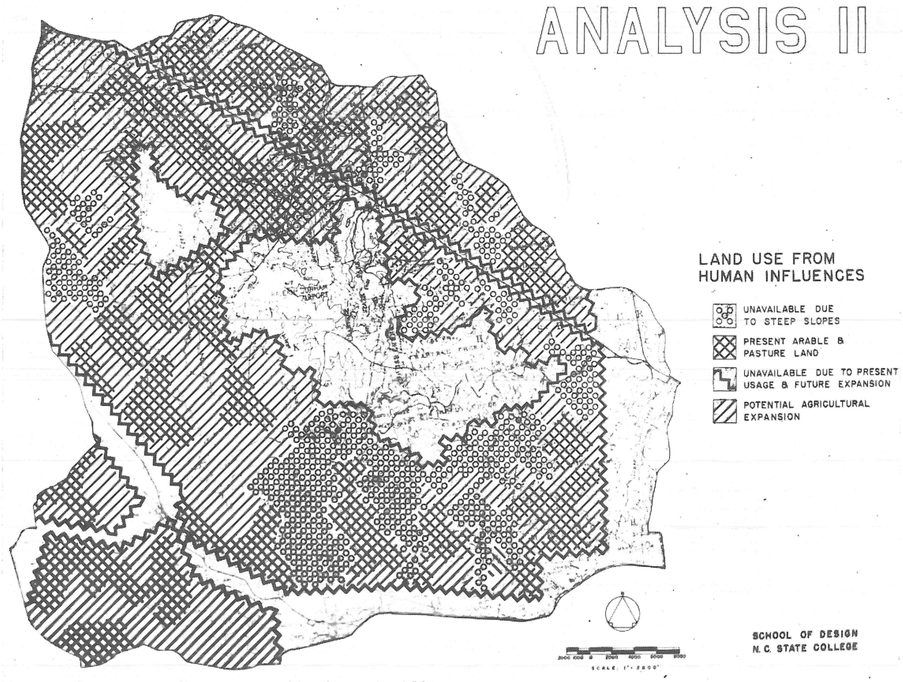
Team A, basing their work entirely upon the natural features of the land, analyzed their survey data to provide a series of categories of ideal land use. These are illustrated on plate IV. Here the site is shown broken into areas especially suited to various basic land uses such as intensive agriculture, commercial woodland and conservation areas. These determinations were based upon particular configurations or combinations of natural features such as soil, vegetation types, and land form. Thus a pattern was established for an ideal development plan of the region.

Team B prepared an analysis indicating the probable growth patterns of an unplanned expansion of the various human influences at work in the region. In addition the area was investigated to determine the limiting features that might establish the patterns of such unplanned activity. In setting down the expansion patterns, such criteria as accessibility, present use and general economic value were used.



This work is graphically illustrated on plate V. Here is a picture showing a direction of development dictated by man's immediate self interest. Two sorts of limits were established to this unplanned activity. The first of these was the natural obstacles such as steep contours, ravines, and main water courses. The other type of limit was the man-made one; legal and political boundaries, such as the properties of state institutions, and such dominating man-constructed carriers as major highways and settlements.

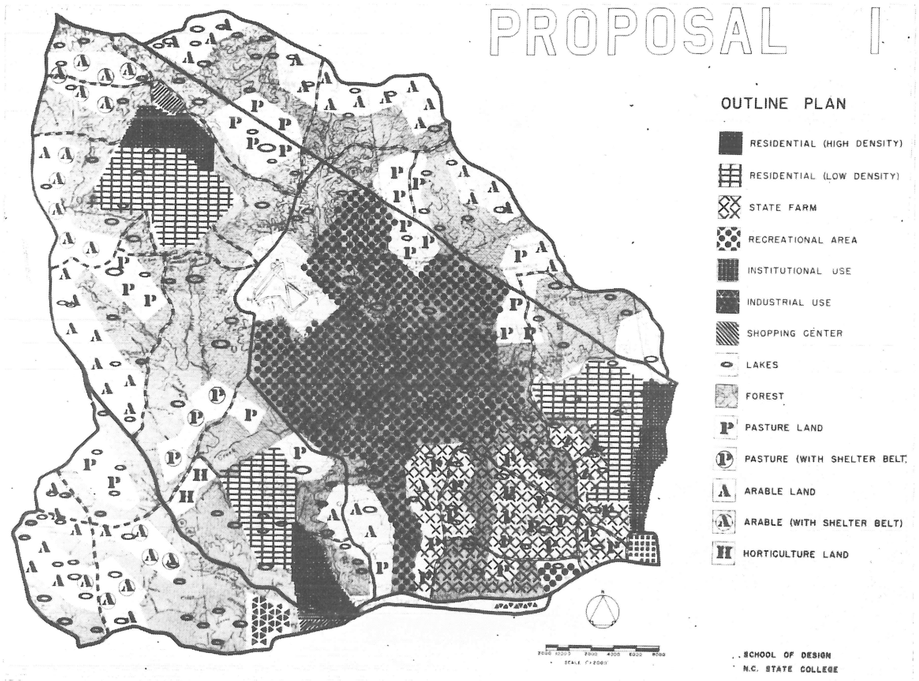
The third area of analysis and projection dealt with the planning and development goals of various public agencies and private organizations with interests in this region. This work took the form of a series of interviews and subsequent reports perpared by team C and summarized here. Most important were the series of interviews with representatives of the government—federal, state and local. The state government is a large landowner in this area; the North Carolina State College Agriculture School Farm and the Crabtree Creek State Park form the largest area of these holdings, which also include a prison farm and the State Fair grounds. The State Authorities foresee a considerable development of the park. Although the actual acreage is not now expected to increase, there is to be an intensive development of the facilities. The increasing population coupled with the better-



ment of the park are expected to greatly increase its use and may provide pressures for expansion in the future.

The State College Farm is expected to be a relatively stable element in the landscape for some time to come. However, the state and federal farm authorities expect the present changing agricutural patterns to lead to accompanying changes in the privately farmed acreages. The dominant trend is toward animal production on pasture land and away from cash crops—tobacco and cotton—and other forms of intensive cultivation. The growth of pasture areas has caused and will continue to cause clearing of additional land and the conservation of surface water. The federal county farm agent suggests two other sorts of agriculture that may be intensified in the future: dairying and truck farming. Increase of dairy herds would increase pasture requirements. Establishment of truck farms will demand a relatively small area of first class soil which must be provided with an abundant dependable water supply.

North Carolina State Conservation and Development authorities predict that their drive for greater industrialization in the state will demand some space in this region for new and expanded light industries. Suggestions for sites include both the south border of the region along the railway and the belt along the major highway running between Raleigh

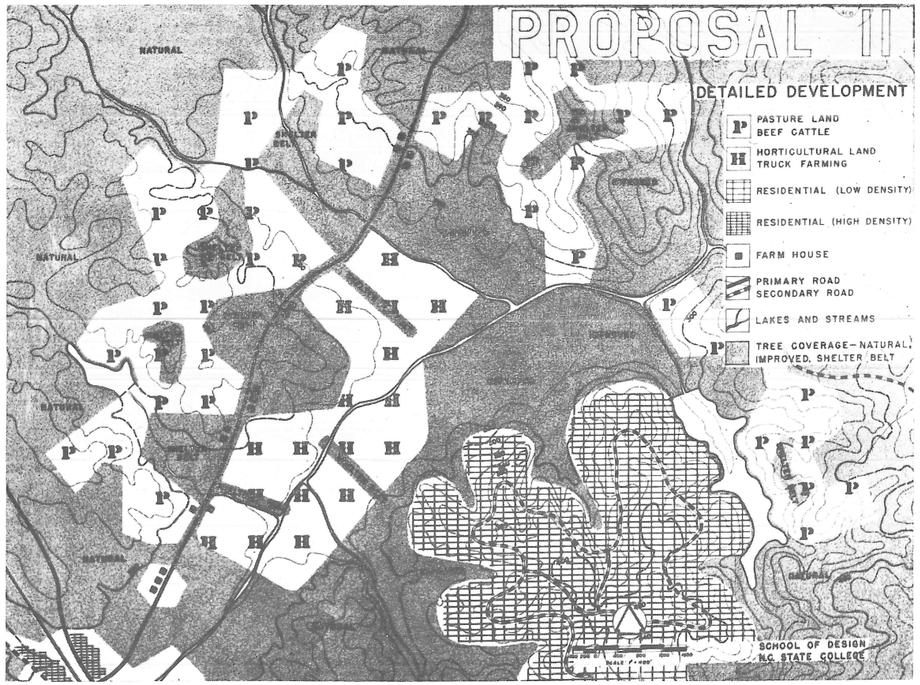


and Durham. However, difficult problems of water supply and waste disposal must be solved prior to such industrial development.

Perhaps the greatest demand for more space in this region is the residential expansion that is taking place as a result of both population increase and urbanization. Strip developments along the various highways already dot the region. Raleigh has expanded into the southeast corner of the site. The largest real estate developer in the Raleigh area predicts the construction of a new satellite town complete with shopping and service center somewhere along the Raleigh-Durham Highway. The chief obstacle to large scale, ordered, residential expansion is the lack of sufficient water supply and the absence of sewage disposal facilities.

Forecasts in the field of transportation and services include the improvement of the main highway on the south of the region and an eventual necessary expansion of the airport facility.

In summary, this second stage of the regional landscape survey and design, provides an analysis of trends and directions for design development in the region from the isolated standpoints of the land itself, the people who presently use it, and the people and agencies who will have most to do with expanding its use. These often divergent proposals form the raw material from which the final design was synthesized.



PART III—SYNTHESIS

On the basis of information gathered in the area survey and the potentials uncovered by the analysis, it became possible for the whole project team to propose a general development plan for the area. Once the overall plan had been formulated, a small section within the greater area was selected for more intensive study. The attitude of the group was that the area should retain its diversified character. High and low density housing, business and manufacturing centers, agricultural and dairy industries already exist: the major problem is to channel the existing potential along the most fruitful lines and to plan for new growth that will augment the land economy.

There were some problems that were apparent at the very outset. The greatest of these were those of housing and new industry. If the population of this area is to grow it is evident that there must be new housing to shelter the people and new industries to provide the increased labor force with work. (The system is an interacting one, of course, for the new laboring population provides part of the necessary market for the new industries.) New housing will arise in four forms; a concentric city growth of high density housing; low density housing between the city proper and the countryside, expansion of already existing small communities, and the building of completely new satellite towns located on or near

the main roads and on picturesque land that is of little use for agriculture or industry. The group decided that only light industry was suitable for the area since heavy industry demands power and water to an extent that is not available. The main problems of siting new industry were access to transport and isolation from residential areas. The area immediately surrounding the Raleigh-Durham Airport and the strip of land between US 1 — US 54 and the Southern Rail Lines on the southern boundary of the area seem the most likely for development.

It is in the field of agriculture that the most significant landscape changes occur. At the present time, the area (with a few exceptions) has many small farms scattered through it that produce a variety of grain crops, cotton, and tobacco. There is no wide spread vegetable farming. With present-day methods of intensive horticulture it is possible for a small land area to produce an abundance of vegetables—enough to feed the entire area. We propose to provide this area in those locations best suited for it. That is, in flat land having good soil, an abundant water supply and good drainage, and speedy access to market. Present farm areas scattered over a variety of soils should be consolidated on the better soils for greater crop production and ease of farming. Much of the poorer farm land could easily be transformed to pasture land to supplement that already devoted to cattle raising and the dairy industry—a move that would strengthen the land economy (see Part II.)

The group strongly urges a new evaluation of the forested portions of the area and of controlled new tree planting. Existing large forested areas should be preserved and improved for their value as recreational assets and as weapons in combating soil erosion and water loss. The group proposes some new tree plantings for those reasons and for these added benefits. Improved forests represent an asset to the landscape and an asset to the farmer in the form of a cash crop that requires little effort. Also, new trees, properly placed can serve as shelter belts which break the force of winds which are harmful to crops and land and provide islands of shade and rest for grazing cattle.

An area located in the SW portion of the region (marked on panel Proposal I) was picked for a detailed study since it exhibits most of the characteristics of the site as a whole. On this map we have attempted to show a detailed application of the general concepts that were arrived at for the greater plan.

The Wider Horizon

Brian Hackett

Brian Hackett is lecturer in Regional Planning at the University of Durham, England, an active planner, landscape architect, and author of numerous articles on the various aspects of wide scale planning. Mr. Hackett conducted a regional planning problem with the students of the Department of Architecture and Landscape Architecture during four weeks of the spring semester, 1955.

It is symptomatic of this age that Man and Nations should look beyond the boundaries of their own territories and place themselves in the context of the world at large. This enlarged view has raised a host of new problems that affect the scope and meaning of man's social, political and economic activities. Landscape design, formerly practiced mainly for the titillation of the well to do, has become an important factor in the solution of some economic problems.

Stated briefly, and with over-simplification, the landscapes of vastly different world regions can be brought into an arrangement wherein one region makes good the deficiency of another. This approach is predicated on a belief that the world's culture is a stable one and the prime concern of governments is the well being of the greater world population. At the present time, however, political jealousies, national pride, and a not surprising desire for economic independence have produced the urge among nations to achieve internal self-sufficiency within their political boundaries. The scope of practice of landscape design has been widened potentially to an extent that is disturbing to those of us who know the narrow limits of theory and practice which have prevailed for many years.

The easy first fruits of the industrial age were favorable in large measure to the growth of cities. The rural landscape became a thing apart; initially able to supply the ever increasing demand for the raw materials of living but never taken into account as a planned adjunct to the city's life process. An increasing necessity for a greater supply of the raw materials that feed the city will surely bring the city developers (which include those who plan as well as those who finance) to a state where they will recognize the interdependency of the city and the landscape and the necessity for discovering and using specialized planning techniques that will assure them of an adequate supply and an equitable distribution of raw materials.

This reference to specialized techniques raises an important point in the wider understanding of landscape design. Specialized techniques in the field of city planning problems have sometimes generated a series of independent bursts of endeavor—a relief road here or a slum clearance project there—that have no relation to an overall plan for city rehabilitation. There is a danger that similar well intentioned efforts will be let loose in the integrated world of landscape. Soil erosion control, the mass destruction of pests, and irrigation are all valuable aids to landscape development, but they can have a negative effect on a balanced landscape if they are not devised as part of a greater landscape plan.

Where the specialist scores is in his expert technical ability. He, alone, is really competent to carry through operations in his particular field. Even so, the landscape is a greater conception than a single specialism, and one looks today for an underlying approach which is common to everything proper to landscape design. This was the intention behind the rural study of an area of landscape which was carried out in February/March 1955 by landscape and architectural students of the School of Design, North Carolina State College.

The crux of the matter, in an underlying approach of this kind, can be stated quite simply as inevitability; that is, an approach so fundamentally basic in nature that, not only

do the specialisms fall into related places within it, but it is in a class of its own with respect to each separate specialism. A study and application of the principles that govern the evolution and maintenance of natural landscapes is valid here and meets the requirements stated.

Possibly the most useful of these principles is that appertaining to the Natural Area—a term used by ecologists to define areas in the landscape with a degree of uniformity in the natural conditions. If the use of techniques based on the Natural Area approach does no more than break down a vast landscape into regions or areas that the human mind can understand, it will have served a useful purpose. In this way alone, it is not hard to see the importance of this approach in the top priority work of opening-up undeveloped areas of the world. It is time that we became aware of the attraction of this pioneering work to many classes of narrow, but essential, specialisms. How plausible sound the arguments of the irrigationist or conservationist! But they can only have meaning when related to the whole landscape, and fitted into place in a development plan which is in fact, a landscape plan.

It is not the intention to decry the importance of the further and corrected development of landscapes already well developed; there is a lot of work of this kind requiring a more fundamental approach than has been applied in the past. But the opportunity is here presented to stimulate interest in the undeveloped areas. As a preliminary, however, three requirements have yet to be satisfied. First, the widening of the scope of landscape education to produce men who can not only survey and plan on the level of the large-scale landscape, but who can meet the specialists at the same level of intelligence. Second, the absence of political or economic bias—to be able to weigh up all points of view. And third, research and more research, of a kind that is not the mere collection and analysis of survey data, but the discovery of principles and techniques, tested by practical application. It is to be hoped that Ph.D applicants and affirming committees will reorientate themselves in this respect.

The Rural Study referred to earlier gave just such an opportunity for testing principles and techniques in yet another state of conditions. But its major purpose was, of course, to show in principle how the particular approach to landscape design could be used at two levels of design: namely, the breaking down of the landscape into units capable of being handled by the human mind, and the improvement of environmental conditions within the units. And not the least interesting feature of the study was the fact that a clearly-defined approach of fundamental origin seemed to unite a mixed group into a team which could work effectively on both special aspects and the wider horizon.

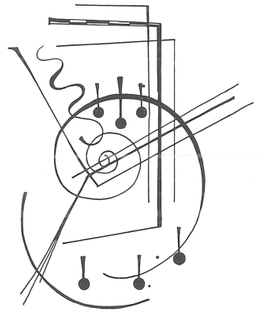
Lawrence Halprin

CHOREOGRAPHY IN THE LANDSCAPE

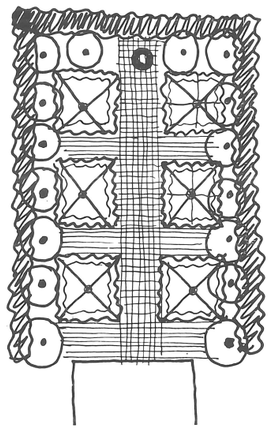
Lawrence Halprin is a practicing California Landscape Architect of national reputation. Mr. Halprin conducted a planning problem with the students of the Department of Landscape Architecture during the fall semester, 1954.

Garden spaces are like stage sets for dance through which people move in ordered and rhythmic patterns. As people move about through these spaces, objects above them - beside them - enclosing them or underfoot - advance and recede - move relatively sideways or backwards - become large or small in a patterned time sequence which takes on all the aspects of a dance composition. Movements vary in tempo—at times fast and jerky, sometimes slow and languid, often completely still as when sitting. As counterpoint, the static objects in a landscape have confined movements of their own—trees sway, leaves vibrate, water tumbles, clouds move across the sky, birds fly from tree to tree. The whole composition is constantly in motion. But the strongest accents, the most powerful movement elements are made by the people within the landscape. The garden is a three dimensional composition of spaces whose divisions and subdivisions, and horizontal and vertical planes confine and mould the movement patterns of the people within it into a choreography closely related to dance.

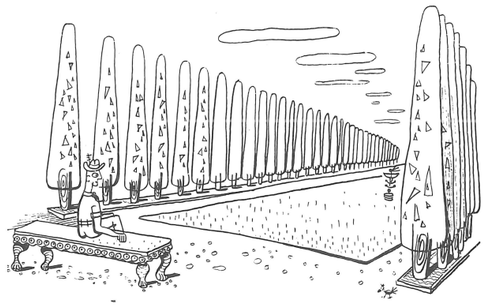
Our earlier landscapes organized movement into a very set and rigid pattern whose confining symmetry echoed in a three-dimensional sense the societies' urge toward order and refinement. Axes were not only visual but established choreographic patterns as well. One stood at the house and looked out into the garden down the long walls to the rear of the property. The boxwood hedges confined the view and the pleached hornbeams emphasized the vista. It was orderly and very neat; the movement patterns generated in the garden were tidy as well. The paths were confined and organized into straight lines. These led about the garden in orderly and regimented patterns, people walked up and down the

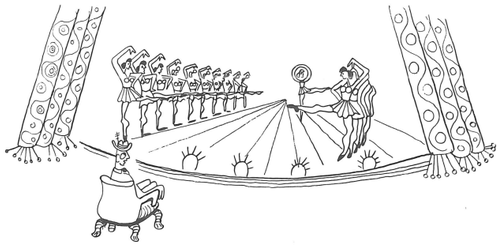


Floor plan of dance "Theme & Variations". Music: Henry Purcell; choreography: Ann Halprin

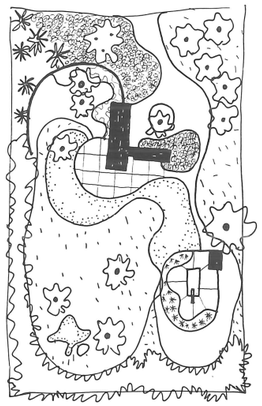


Plan of old fashioned "Static" garden





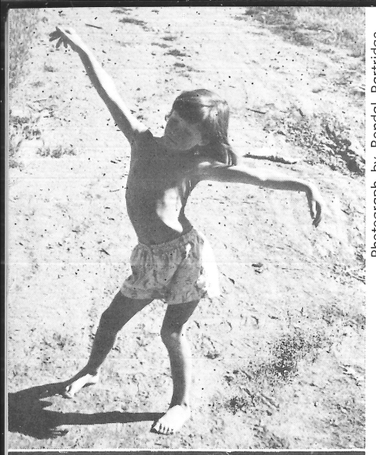
Drawings by Author



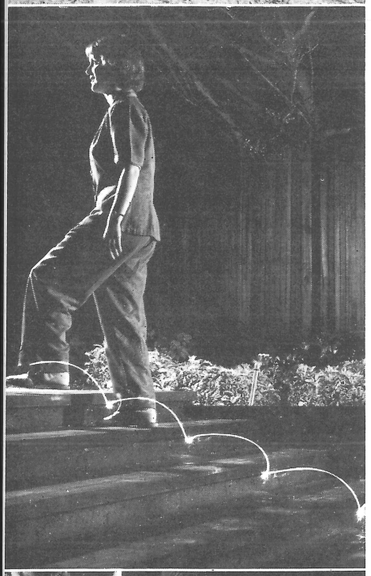
Plan of 1. Schuman garden in Wood Side, California. A garden on 4 acres. The meadow weaves throughout; live oaks dot the property areas for play, seclusion, swimming, golf, sitting. Lawrence Halprin, landscape architect.

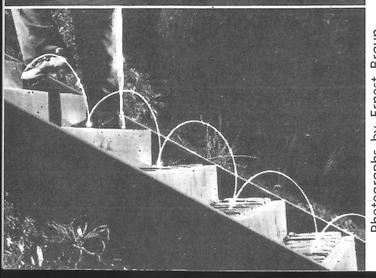
paths quietly and in a distinguished fashion, in rectilinear patterns —almost two-dimensionally in space. The tempos were quieter and the rhythmic patterns less variable and more orderly than those to which we are accustomed today. There is a very real and close relationship between the movement patterns generated within the gardens of the 18th and 19th centuries and the formalized dances of the day. This was a time of courtly gaillards and minuets, those slow and pompous court dances in which ladies and gentlemen, ranging themselves on either side of a long hall, bowed and curtseyed, extended hands and glided past each other in measured tempo. It was a time, in theatre dance, when ballet flourished and ballerinas danced on point in symmetrical patterns.

Today we are more peripatetic. The tempo of our civilization is faster and more syncopated—our movement patterns are broader and wilder. And the tight and symmetrical garden, the rectilinear and confining space no longer serves as an adequate stage within which we must play our part. The scenery needs to explode, the painted and stilted backdrops must give way to the wider landscape of nature and the static garden forms of terrace and screen of hedge and tree must modulate the movement rather than confine it. We need gardens whose form and interior spaces enhance and enrich our movement patterns so that these take on the free and purposeful sense of a garden choreography designed for our time.



Photograph by Rondal Partridge





Photographs by Ernest Braun

Children know this instinctively, and their playground ranges over the whole property. Where barriers do not exist, they create them to clamber over—where sharp angles protrude, they break them off or cut across the grassed corners on rounded curves. If tricycling space is not designed for around and around motions, then we soon find the tricycles in our laps when we sit down for a moment's rest. The sense of garden as play space in motion is the very basis of garden design for children's use.

The ordering of movement on a property, of course, starts with the site plan. The whole essence of a scheme hinges on this movement of basic decision. The rest is secondary. Where do we put the house, what level is the floor, how does this relate to the ground, where is the driveway, how does the terrace sit, these are the primary decisions. They are governed by a multitude of factors—land, views, orientation, etc. But we need always to think of the choreographic implications of these decisions, and how strongly site use and site plan affect the living and moving patterns of the family or families on the land. Terraces down six steps from the house floor receive less use by far than those at floor level. Direct ground contact makes easy in and out movements possible and enjoyable. Yet there is room within the garden for a vertical sense of movement by a shifting of levels whose up and down quality can give another dimension to the movements on the site. Vertical movement, when properly designed, can add as much richness and quality to the use of a site as can the patterning of movement in the horizontal plane.

Nor does the vertical difference need sharp lines of demarcation. The swelling and rolling of land forms even at small scale gives opportunities for ramps and slopes whose easy rise and fall can contrast with the staccato of flights of steps and the vertical barriers of walls or ditches over which ladders scale or children jump.

In the horizontal plane spaces can be defined through screens or hedges, rows of trees, or low walls which channel movement in and around and into deep forward and backward penetration in as rich and varied a pattern as the designer desires. The essence of the garden is living participation and to achieve this, more than merely visual delight is needed.

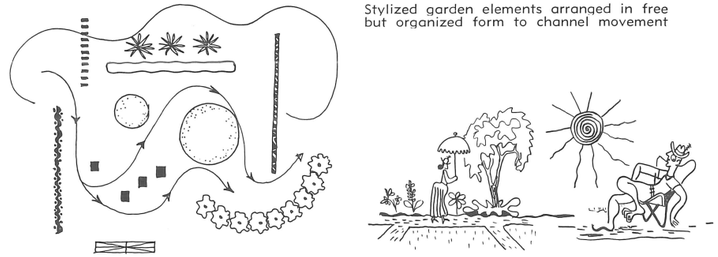
Through the careful extension of terraces into the depths of a

Center Left: Riser 5½", Tread 17"

Lower Left: Riser 9", Tread 11"

property, of walks and ways leading around throughout its length and breadth, movement into all of its parts is encouraged and a deep and meaningful sense of actively belonging to the site is encouraged. It is no longer sufficient to sit and enjoy a pretty view of the garden. We want to move out and among the trees joyfully in pleasant patterns underfoot, sit among the trees, look back at the house and moving again along walks and paths, return to sit again. The varying rhythms of motion and the quiet of sitting and moving must both be planned for.

The changing relationship to the static objects in a garden must be mentioned. As movement occurs through garden spaces, one's relation to objects becomes one of ebb and



Stylized garden elements arranged in free but organized form to channel movement

flow, of nearness and farness, of close contact, passing and then leaving behind. A sort of doppler effect results both audibly and visually in which the degree of detail varies in the seen and heard object. A blossoming apple tree seen from afar is simply a bower of whitish pink flowers. Moving closer one begins to distinguish branches with sprays of 5-petaled individual flowers, and the hum of bees becomes louder and more noticeable. Still closer, and the venation of the petals, the anthers and pistil—even the pollen on the leg of the working bee frantically gathering food for the hive, comes into focus in a miniature close-up world. As one moves on, the apple tree recedes in the background with its flowers and bees. Other images loom up ahead. Though the tree has been left behind, an awareness of its position in space still remains and one feels it behind—spatially— as related to the back of one's moving body. The garden spaces envelope the moving person as water envelopes the swimmer and the static objects become points of reference in a changing space. Underfoot textures change and are felt, bricks are uneven and move slightly, asphalt walks are softer and more pebbly, the grassy slope is verdant and springy underfoot. The change in movement pattern here can become a tactile change as well as a visual one.

The rapidity of movement itself can vary the experiences in the landscape. This is particularly true in the larger landscape of park and field and street scene and parkway. A

walk along winding paths in the city park in continuous but slow movement has an almost hypnotic and soothing effect—the path winds slowly, rising gradually, the walking movement becomes automatic, trees pass, water is first on the left and then on the right, ducks quack, birds sing—it is a scene intimately experienced. The same experience seen from a car moving through the park at higher speeds calls forth a completely different empathic response. At 45 miles an hour only the big elements are seen—there is a lake with trees around it and beyond a grassy field. These are passed in a moment and the next element appears. The park remains the same but the rapidity of the movement through it has changed its appearance for the moving person. Parkway design must recognize this element of rapidity of movement along its roadbed by a design which is related to the quickly moving person. Long radius curves, bold planting in masses, strong variations in land forms, large scale opening out and closing in of surrounding spaces are important elements in this high speed design. The danger, as we all know, is the somnambulistic effect of repetition due to movement. Where lethargy may be a welcome result of a 3-miles-per-hour stroll through a park, it can be dangerous at 55 miles per hour on a parkway. Strong and violent contrast in the landscape may therefore be at times desirable in order to break up the repetitive pattern of change and vary the effect sharply. The principle of design for movement must therefore take into account not only the moving person, but attempt to prevision the speed at which he will be moving through the spaces of the landscape.

Thus, space comes alive and becomes meaningful as area for movement; within it, objects stand—defining boundaries, establishing reference points, modeling it into perceptible parts which relate to the whole. And through these spaces, generated by design, move the people for whom they were created in ordered patterns. Given inspiration, their movement patterns can take on all the sense of an art form, so that not only the landscape through which they move is a work of art, but their movement through it partakes of all the high quality of dance.