

W. Pedersen

Dispersal of population, government and industries.

It has been suggested that perhaps the only measure of defense against atomic bomb attacks which could be undertaken by a single nation is that of a dispersal of the large centers of population, industries and government. Let us examine some of the factors relevant to such a decentralization, and attempt to evaluate the possible advantages thereof.

Let us first consider an extreme case of such a decentralization. According to statistics of 1940, 47.6 % of the population of the United States (66,000,000 people) live in towns of 10,000 inhabitants or larger. I assume that 66,000,000 people are necessary to the efficient functioning of the industries of the country at their normal peacetime level, i.e. this number of people include the employees of industry and their families, plus the people who are necessary to the life of the community, the small shopkeepers, the municipal employees, the distributors, the transport workers, the professional people etc. I assume also that industrial towns cannot function with the efficiency necessary to maintain a reasonably high standard of living with less than 10,000 inhabitants per town. (This is almost certainly an extreme underestimation). Thus the number of towns will be about 6,600, and this number of atomic bombs of the variety at present available will wipe out our industry, our communications, our government and at least one half of our population.

What can one say concerning the magnitude of the job of effecting such a dispersal, what of the cost, and how long will it take? The industries of the country are now, in great majority, located in or very near the very large urban communities concentrated over a small fraction of the land area of the country,

mostly in the northeast. Since we may reasonably expect that within the minimum possible time, say ten years, in which such a dispersal can be effected, that there may be in existence atomic bombs whose area of devastation approximates the span between this number of towns spread uniformly, nothing less than such a uniform spreading out of our towns over the approximately 5,000,000 square miles of continental United States is worth consideration. It has been roughly estimated that the cost of dispersing our cities to towns of 100,000 maximum inhabitants would be 200 billion dollars, exclusive of the value of the land, and of the dispersal of the railroad and highway transport facilities. Lengthy consideration of the magnitude of this task leads me to believe that the job could not realistically be done in less than 25 years.

What are the chances of a nation accumulating, say, 10,000 atomic bombs with which successfully to attack us? According to a recent newspaper release Niels Bohr estimates that the present rate of production of plutonium plus U-235 is three kilograms per day. I assume half of this to be plutonium manufactured at Hanford, and further that this amount is equivalent to 50 bombs per year. Thus 20 such plants could produce 1,000 bombs per year, and such a production rate appears to me to be within the capacity of a country such as Russia.

What of the cost? Mass produced, plants similar to that at Hanford plus all auxiliary equipment used in bomb fabrication would probably not cost more than \$250,000,000 apiece, or \$5 billion for 20. Russia can certainly afford this much.

How much Uranium would be required for such a production rate? I estimate that about 3,000 tons per year are required for each such plant, (the Uranium could be recovered yearly) or 60,000 tons for 20. The standard source books say there are about twenty thousand tons of visible uranium on earth. This value has probably increased

greatly, or at any rate soon will be increased through extensive prospecting. If one includes the possibility of the use of other potentially valuable minerals, the problem of source materials seems a soluble one, if only for a country with the vast unexploited areas of Russia.

Thus, it appears that, even barring the improvement of present day bombs or the discovery of other practical nuclear reactions using more available materials or releasing more energy, we must face the probability that in ten to twenty years even a thoroughly dispersed population and economy could be completely destroyed overnight.

I believe we must even expect that within, say 25 years, the development of nuclear explosives will render possible the devastation of a significant fraction, if not all, of the land area of the U.S.A. and possibly the destruction of the planet. Even present day bombs destroy more than 5 square miles, and probably are improvable by say, tenfold, so that 10,000 such improved bombs can cover 50,000-500,000 square miles of the 5,000,000 odd square miles of the country. They could easily cover all coal mines, oil wells, dams and water power sites, iron mines, all urban areas, and more important still, the area of the largest possible closed or concealed reservations set aside for the manufacture of atomic bombs. Specific installations of geophysical importance such as the Sault St. Marie locks, the Panama canal, the Rocky Mountain road and railroad passes are easily vulnerable.

What all the foregoing means is that it is impossible to get away from the atomic bomb- there is no escape. It seems to me that anything we may suggest in the way of an implied escape of the consequences of a war in the atomic age is a delusion and a serious weakening of the arguments for a world government, all of which assume this fundamental truth.

38. LEO SZILARD

MEMORANDUM ON DISPERSAL OF POPULATION AND INDUSTRY

I

Dispersal of Cities as a Secondary Defense Against the

Atomic Bomb

The desirability of dispersing population and industries, which has long been considered on other grounds, has been raised anew by the invention of the atomic bomb. In view of the destructive power of the atomic bomb and the consequent vulnerability of large concentrations of population and industries, plans for reconstructing our patterns of settlement and industry in the United States will probably be considered in the near future.

There is the danger that preoccupation with questions of this sort is likely to distract us from consideration of the primary issue, namely the necessity and possibility of controlling the further development, the manufacture, and the use of the atomic bomb on a world scale. There is the further danger that we may be lulled into a false sense of security by the discovery that it is possible and feasible to gain by dispersal a greater measure of invulnerability against the weapon than we have at present and that consequently, we may use less than our total energy to bring the weapon under world control. The mere discussion of this secondary issue of dispersal is likely to have dangerous consequences, for it will tend to make us regard the imperative necessity of finding an effective world organization for the control of the weapon as less urgent and inescapable than it is.

It is well to keep in mind, therefore, that in the discussion of social adjustments to the atomic bomb, first things should come first. And the first thing is the immediate development of an effective world control of the weapon through political means.

Only in the event that the prospect of developing this control is so remote as to leave us exposed to mortal danger should the secondary defense against the atomic bomb in the form of dispersal of our cities and industries be seriously considered as an alternative. The very fact that we are considering this secondary defensive measure may lead other countries to believe that we are not convinced of the inescapable need for world control of the weapon and may intensify resistance on the part of other nations to world organization for this purpose.

If the emergence of a world control organization would be long delayed, it may be necessary, despite the provocation which such a policy might imply, to proceed on a process of dispersal as an interim measure. In that case, time would be of the essence and such a process would have to begin at the earliest possible moment and be carried to completion in the shortest possible time. This would obviously increase the cost and the dislocation involved. Given the fact of the unattainability of an effective world organization, we should want to know from the experts approximately how long it will take before other countries will be in a position to use the weapon against us so as to know into what time-span we will have to concentrate the dispersal. If it were to cost us approximately 15 billion dollars a year over a period of 10 years to carry out the minimum dispersal program, it would cost considerably more than twice that amount to concentrate it into a five-year period, and the dislocation to the economy and the society would be proportionately greater. Even under the incentive of the greatest urgency, we should probably not be able to complete even a minimum program of dispersal in less than five years.

Having called attention to the negative consequences of a program of dispersal, we should not fail to recognize that the determination and publicizing of the tremendous costs of such a program together with the necessary changes in our economy and society which it entails might in itself serve as an incentive to persuade the American public and its leaders of the inescapable need for world control as the lesser of the two evils. If, in addition, it could be made clear that even after a program of dispersal is carried out successfully, we would still only have partial invulnerability against attack, the incentive for America to take the leadership in forming an effective world organization would be even greater.

Advantages of Dispersal

Long before the invention of the atomic bomb, there has been widespread discussion among students of urbanism, city planners, and the enlightened public in this country and other countries of the advantages to be obtained by, and the need for, the devolution of cities and especially of metropolitan districts. Among the items most frequently mentioned as constituting disadvantages incident to the excessive concentration of people and industries in cities were:

- (1) High costs of urban land
- (2) High costs of urban government
- (3) High costs of industrial production in urban areas
- (4) Tendency toward the development of slums and blighted areas
- (5) Traffic congestion
- (6) Unfavorable influences upon marriage, child bearing, child rearing and family life

- (7) Adverse influences upon the development of neighborhoods and local community organization
- (8) Adverse influences upon democratic living; corruption in government; non-participation in the political process, segregation and social and economic stratification.
- (9) High rates of delinquency, crime and social disorganization
- (10) Adverse influences upon health: danger from contagious diseases and epidemics and stress and strain upon the human nervous system.
- (11) Noise, grime and smoke
- (12) Dependence upon employment and economic security without capacity for self subsistence in case of unemployment
- (13) Absence of contact with nature and need for man-made recreational facilities
- (14) Reduction in leisure due to time consumed in moving to and from work
- (15) Reduction in intimate personal contacts and increase in personal frustration
- (16) Vulnerability in case of war especially from attacks by air

While the human and material costs of urban concentration are undoubtedly great, they have been compensated for, at least in part, by the greater economic opportunities, the heightened personal competition, the cultural advantages, the freedom, the stimulation and the psychological magnetism of the city, especially the great city.

Doubt has frequently been expressed as to whether the benefits that derive from modern technology, science, culture, large-scale production and the division of labor could be retained without dense concentration of large masses of heterogeneous people, material facilities, and social institutions in great urban centers. While it has been recognized that diminishing returns in all of these respects set in, once a city reaches a certain size, the optimum size of the city from an economic and cultural standpoint remains to be determined.

As a result of the unfavorable factors associated with living and working in metropolitan cities and consequent upon the development of rapid transportation, the growing cities of the United States have spilled over their municipal boundaries. This development, although it has emptied the core of our great cities of a large proportion of their residents, has not resulted in an appreciable loosening up of the urban structure and constitutes merely a limited decentralization within metropolitan regions. The dispersal we have experienced thus far is merely a trend toward an ever widening circle of suburbs which can exist only, however, as long as there is a central metropolitan city. It is doubtful, for instance, whether the opera, the symphony concert, the great department stores and specialty shops, the press, radio and publishing houses, the great medical centers, hospitals and educational and cultural institutions could exist if it were not for metropolitan centers. There is no doubt, however, that instantaneous communication, rapid transportation and modern developments in social and economic organization make probable the wider dispersal without appreciable loss of the advantages hitherto obtainable only in metropolitan centers.

It is clear that our cities and our metropolitan centers, as they now exist, are far from being the most efficient places in which to live and in which to work. It is also clear that except for the historical circumstances that gave rise to them, a great many of our cities have lost their reason for existence where they now are, and might as well be relocated elsewhere or broken into smaller units. It is also true that our cities were vulnerable to attack even before the invention of the atomic bomb, and that security in time of war has been given increasing attention by planners in recent years, especially with the development of air warfare.

For maximum security against the atomic bomb, however, it should be understood that the recent trend toward suburbanization is not enough, for the suburbs presuppose the continued existence of the metropolitan center virtually in its present form and themselves constitute major concentrations of population and industries contiguous to the central city and to each other. Dispersal adequate for defense against the atomic bomb would require as a minimum, the relocation of existing suburbs over a much wider radius from the city center, and in a discontinuous relationship to one another. The minimum requirement for metropolitan decentralization, therefore, would be the absolute decline of the central city and the development, instead of suburbs, of more distant outlying satellite towns.

The Magnitude and Implications of the Task

There were in the United States in 1940, five cities with 1,000,000 or more inhabitants, nine cities between 500,000 and 1,000,000 twenty-three cities between 250,000 and 500,000, fifty-five cities between 100,000 and 250,000, one hundred and seven between 50,000 and 100,000 population. We had then, ninety-two cities with 100,000 and over

and one hundred ninety-nine cities with 50,000 and more population. Approximately 29 per cent of our people lived in cities of over 100,000.

An even more important measure of urban concentration of the United States is the proportion of population living in Metropolitan Districts¹. The 140 such Districts in 1940 contained nearly 63 million inhabitants or approximately half of the population of the United States. Of these about 43 million lived in the central cities and 20 million in the suburban territory. The war has further accentuated this metropolitan concentration, since approximately three-fourths of the new war plants were located within the metropolitan areas of cities with a population of over 100,000.

The decentralization of population would necessarily have to be synchronized with the relocation of industry, administration and transportation. There are limits set by the location of natural resources beyond which the relocation of industry cannot go without encountering extremely adverse conditions. Similarly there are minimum limits to the size of plants, especially in heavy industry, below which economical operation is questionable. Although dispersal could probably go far beyond its present stage without encountering serious obstacles and, indeed, might be economically desirable, planning to bring about a pattern which would be sound from both a military and economic point of view presents complex national, regional and local problems.

¹ A Metropolitan District has been set up by the U. S. Census (1940) for each city of 50,000 or more (sometimes 2 or more being in one district), including generally all adjacent and contiguous territory having a population of 150 or more per square mile.

What is true of industrial relocation applies equally to transportation. The railroad network of the country constitutes the most important and difficult phase of this problem. In view of the relatively high degree of obsolescence of our present transportation system, however, there might be sufficient incentive other than that of deriving from defense to induce the nation to undertake it.

The development in recent years of vast hydroelectric power projects has already brought about a certain degree of relocation of old, and creation of new industrial areas in hitherto nonindustrialized areas of the United States. The existing power centers and the exploitation of new potential sources of power promise to bring about important interregional shifts in population and industry. Since the advent of the atomic bomb and of the large-scale hydroelectric power development in this country roughly coincide, there should be little difficulty in planning the industrial and urban dispersion in the regions of large new power resources to fit in with the needs for defense against atomic warfare.

The relocation and dispersal of the administrative, commercial, service and institutional centers of the nation would pose problems similar to those involved in the decentralization of industry. These problems would, however, not be insuperable.

Aside from the technological and financial problems which the dispersal of cities and industries involves, we must consider the political, economic and social adjustments incident to such an undertaking. To say the least, it is unlikely that these changes could be brought about in an orderly manner, on a purely voluntary basis. Billions of dollars in property values would be destroyed by the removal of residences, industries, business establishments, and other

facilities from the central cities. The offer of free land by the government in outlying new areas would not compensate for these losses, for the value of urban land consists solely in its location. It should be noted, however, that the loss of property values in urban land would not be a destruction of real wealth, although it would undoubtedly have profound political repercussions.

The losses incident to the shift-over from the existing to the new pattern would also be enormous, although they could be minimized by retaining the existing structure until the new structure is completed.

When we consider the intangible human and social cost of the vast--and yet relatively insignificant--mass uprooting and migration of people and industries during World War II, the prospect of relocating the people, industries and facilities of all cities and metropolitan regions of over 100,000 or even of over 1 million appears staggering.

In order to execute such a relocation plan it would obviously be necessary to carry it out on a national scale. It would probably have to be carried out at public expense and under public control. The minimum requirement of public control would be that residents and industrialists would be told where they could not locate without being told where they must locate. Since the relocation of individual industries, facilities and residences would, however, depend upon the similar or different intention of others, the public control necessary would virtually have to be total and enforceable through law.

Even after the completion of the initial relocation, public control would have to continue indefinitely to prevent the pattern

of settlement and industry from getting out of hand. Public ownership of urban and industrial land would probably be an indispensable prerequisite for accomplishing and maintaining the desired pattern.

The concentration of power in the hands of the national government which such a program calls for, implies a fundamental change in the form of government of the United States which would either require fundamental constitutional revision or the declaration of a state of National Emergency for an indefinite period.

Considering the magnitude, the technical difficulties and the material and social cost of the changes necessary to make the United States invulnerable--or rather relatively invulnerable--against atomic warfare, the conclusion appears to be obvious that it would be far better for this nation to put all of its eggs in one basket by proceeding forthwith to develop an effective world organization for the control of the atomic bomb.

Louis Wirth

APPENDIX A

Taking 1940 Census figures as our base, and assuming that any population center over 100,000 is vulnerable we arrive at the following estimate of the minimum number of cities required to absorb the "surplus" urban population:

City Size	Num- ber	Total Population	Number of new cities of not more than 100,000 each, necessary to absorb population
Places of 1,000,000 or more	5	15,910,866	159
Places of 500,000 to 1,000,000	9	6,456,959	64
Places of 250,000 to 500,000	23	7,827,514	78
Places of 100,000 to 250,000	55	7,792,650	77
TOTAL	92		378

Assuming that each of the cities of 100,000 or more would continue to exist as a city of 100,000 or less, and that the surplus population would be relocated in new cities of not more than 100,000 each, it would require the construction of 378 - 92 cities or 286 new cities to accommodate the displaced population. It is, of course conceivable that, instead of building entirely new cities, the displaced population would be relocated in existing cities of less than 100,000 so distributed as not to exceed the 100,000 mark in any one city. In this manner we could absorb the surplus population without the creation of new cities by merely enlarging and reconstructing the existing cities of lesser size. The suitability of the existing cities for the absorption of the surplus population would have to be determined.

If the optimum size of a city were taken as 50,000 instead of 100,000, the problem of relocation would be modified as follows:

No. of cities 50,000 to 100,000 = 107

Population in cities 50,000 to 100,000 = 7,343,917

No. of cities required = 146

No. of cities required for population of cities over 100,000

$(378 \times 2) = 756$

Total number of cities required $(756 + 146) = 902$

Number of existing cities of 50,000 and over $(107 + 92) = 199$

Number of new cities required = 703

APPENDIX B

The dispersal of cities and the resettlement of population and industries will increase the margin of safety in the face of attack by atomic bombs in the following manner:

- (1) by reducing the number of casualties and the amount of physical destruction that a given number of atomic bombs can cause
- (2) by enabling us (the attacked nation) to retain a greater proportion of our defensive power and giving us more time to employ our offensive strength against the potential enemy

Presumably, for the time being, the number of bombs which can be produced by any one country is limited and through the dispersal of our cities and our productive plant we can increase our chances of preventing demoralization and large scale destruction by sudden attack. Our power to retaliate, if known to the enemy, might conceivably induce him to refrain from attacking us in the first place.

In order to reduce our vulnerability further after dispersal and as a possible alternative to dispersal the adoption of suitable city plans offering the maximum immunity should be considered.

On the basis of published information we cannot as yet be certain of the exact area and intensity of destruction of a single bomb. Nor can we anticipate the prospect of the development of bombs of greater destructive potential. The official preliminary report by Brig. Gen. T. F. Farrell, chief of the American atomic bomb mission, on the destruction wrought in Hiroshima reveals the following:

- (1) "For a radius of one and a quarter miles from the point of detonation, the area was completely pulverized."
- (2) "To a radius of two miles everything is blasted with some burning."
- (3) "Between two and three miles, the buildings are about half destroyed."
- (4) "Beyond three miles, the damage is generally slight, with roof damage up to five miles and glass broken up to twelve miles."
- (5) "Light shelters were caved in, streetcars were derailed and burned, automobiles had the roofs caved in. A fire started in a forest on a mountain four miles away."

The varying degrees of damage inflicted have been graphically presented in relation to the area of the Chicago metropolitan district in diagram I.

It should be noted that if the bomb which ravaged Hiroshima had been dropped in the center of Chicago it would have totally destroyed the entire central business district, the area of light manufacturing, the wholesale district, the warehouses and all of the railroad terminals together with most of the high grade hotel and apartment area in the inner city and the major part of the blighted area. The lesser damage would have extended throughout the entire city and many of its major suburbs.

In the face of such destructive power several alternative types of city structure might appear to be at least in part of defensive use:

- (1) Limitation of the height of buildings to approximately ten floors in the central area and not more than four floors in the residential areas.
- (2) Complete fire-proofing of buildings.
- (3) Abolition of gas and coal as fuel and substitution of electricity.
- (4) Building as large a part of city structures as possible underground.
- (5) Cellular development of cities in the form of discontinuous and relatively self sufficient communities approximately 5 miles distant from each other as indicated in Diagram II.
- (6) Ribbon development of cities of approximately 1 mile in width and of indefinite length as indicated in Diagram III.
- (7) A combination of 5 and 6 above, as indicated in Diagram IV.

In order to transform the present city of Chicago into the form suggested by Diagram III, for instance, it would have to stretch over a length of approximately 200 miles. This would obviously be impracticable. A city of approximately 50,000 population, however, could be planned for residences, industries and services in a one-mile wide ribbon approximately five miles in length. The location of power stations, railroad terminals, industries, residences, business and service establishments in a reasonably efficient functional relationship to each other would not present insuperable difficulties, especially in view of the simplicity of transportation facilities under such an arrangement.

DIAGRAM I

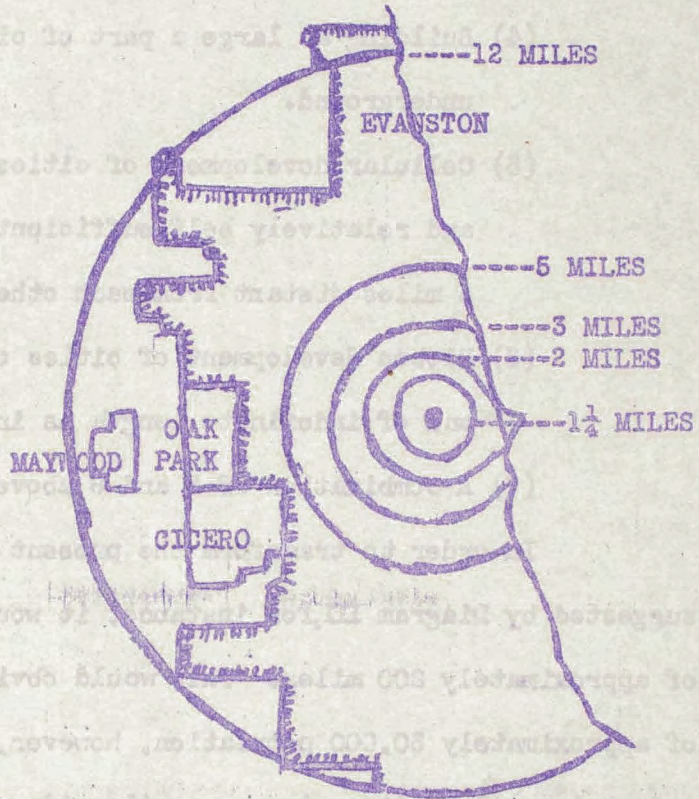


DIAGRAM II

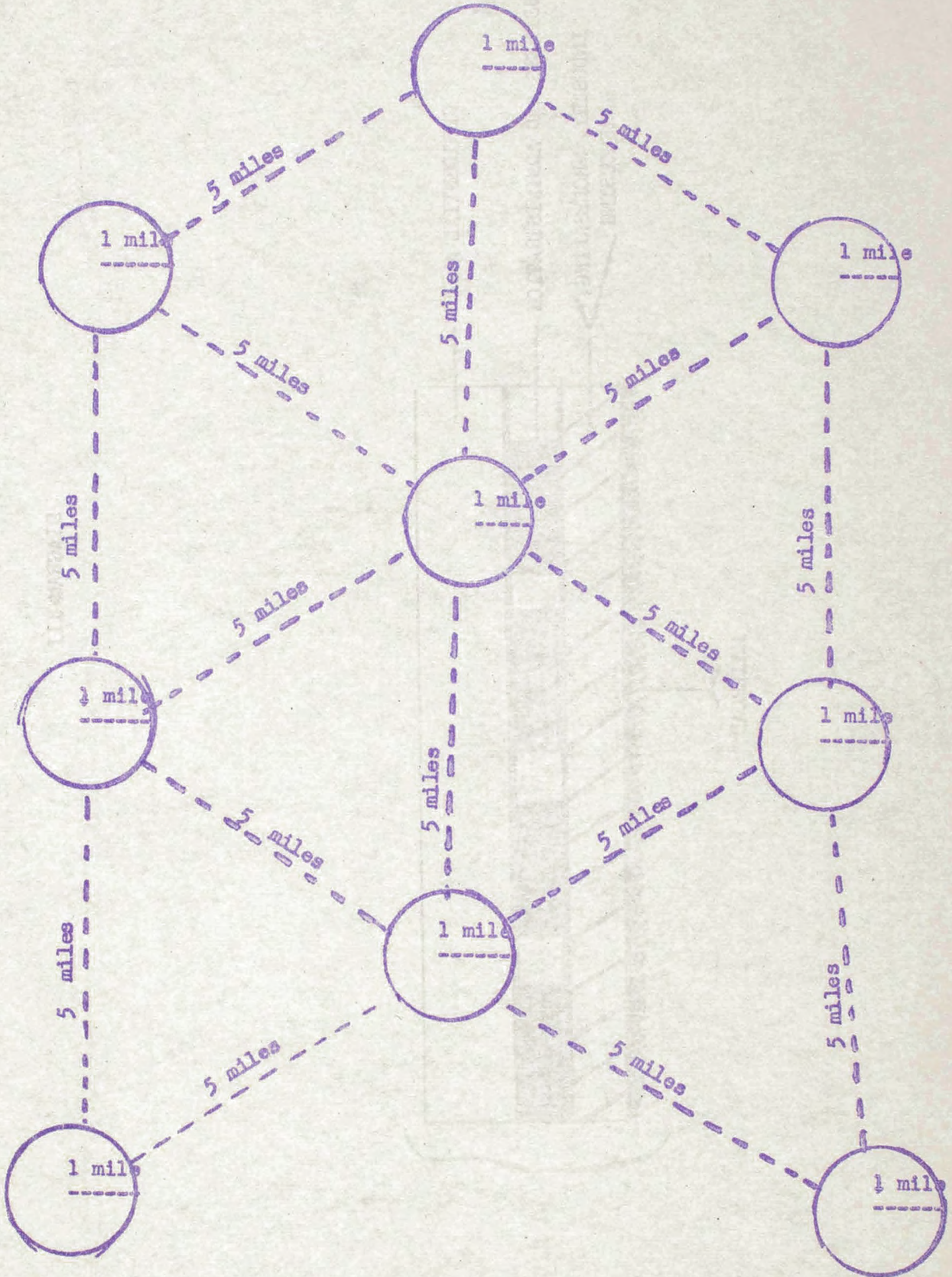


DIAGRAM III

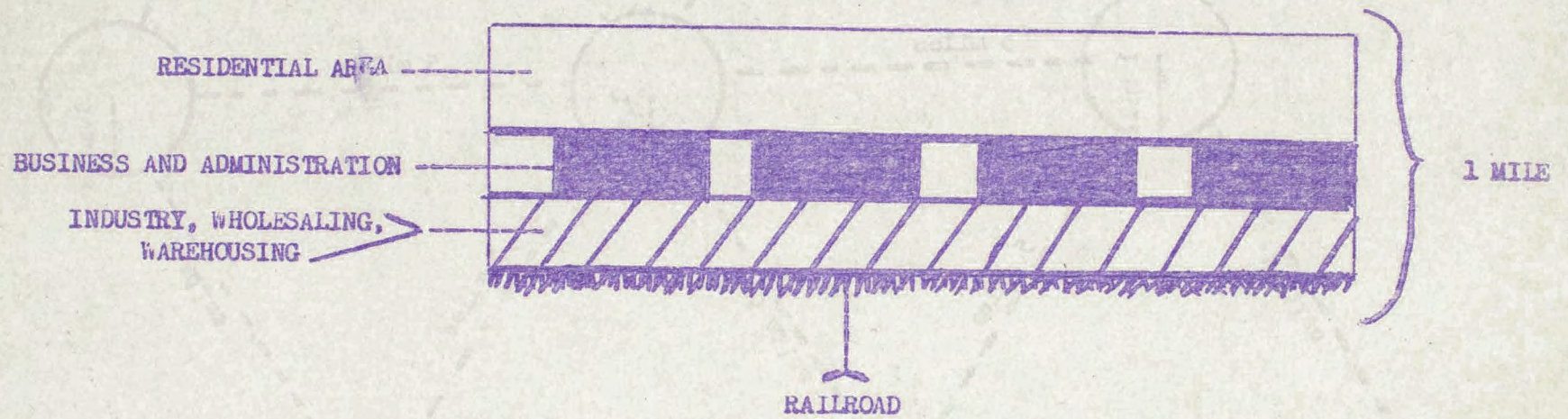
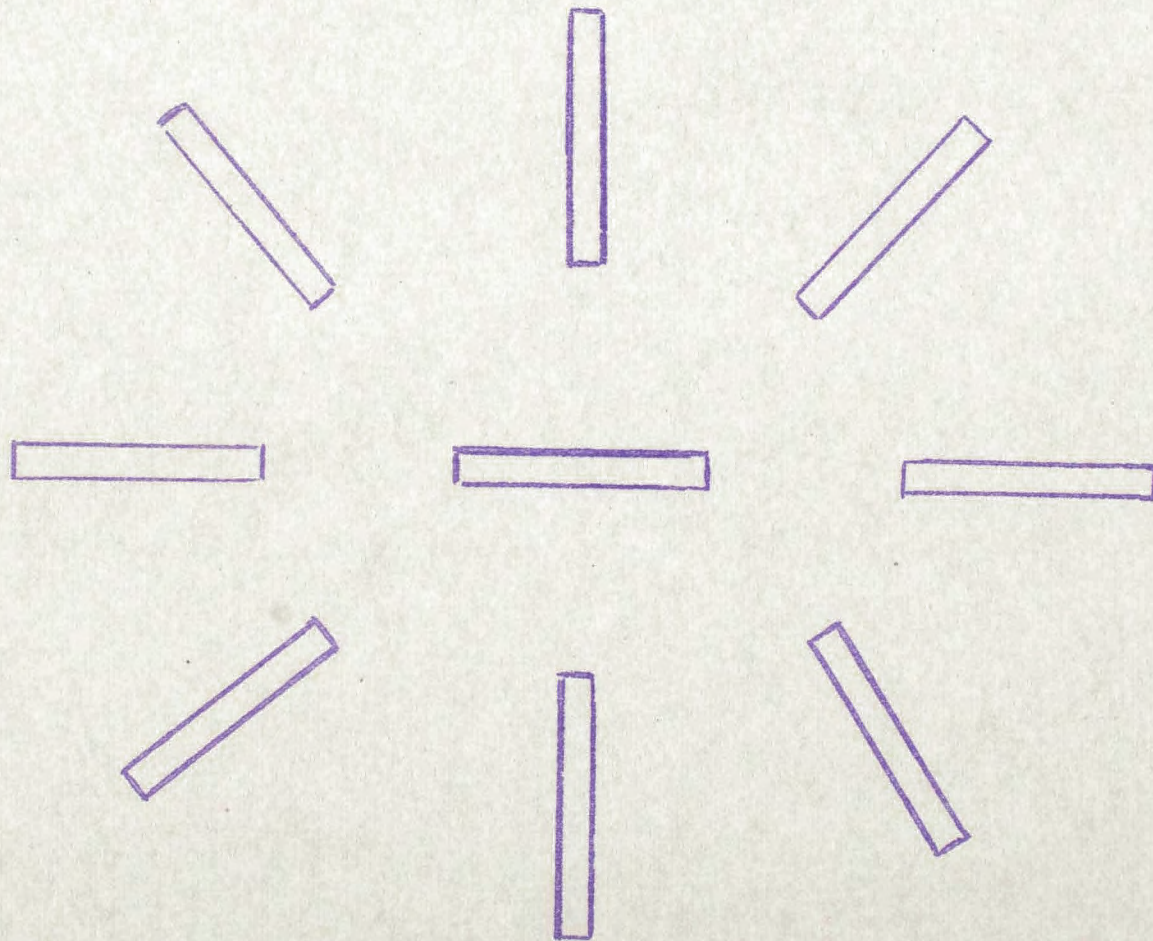


DIAGRAM IV



Greenon
why it rose and
decreased 1943-44

Musford: The City
1944-45

Hearing on Thomas
Bull (Robert T. apt
Armstrong) Jan 1945

HOTEL STATLER BUFFALO

National Housing
Agency (Bull) [John
B. Blandford Jr. Administrator]

Thomas Bull

Division of Urban
Studies.

Nat. Res. Pt. Program
and other, their role
in the Nat. Ac. 1937

Dept of urban affairs

(Div of Urban research)

Form of other:

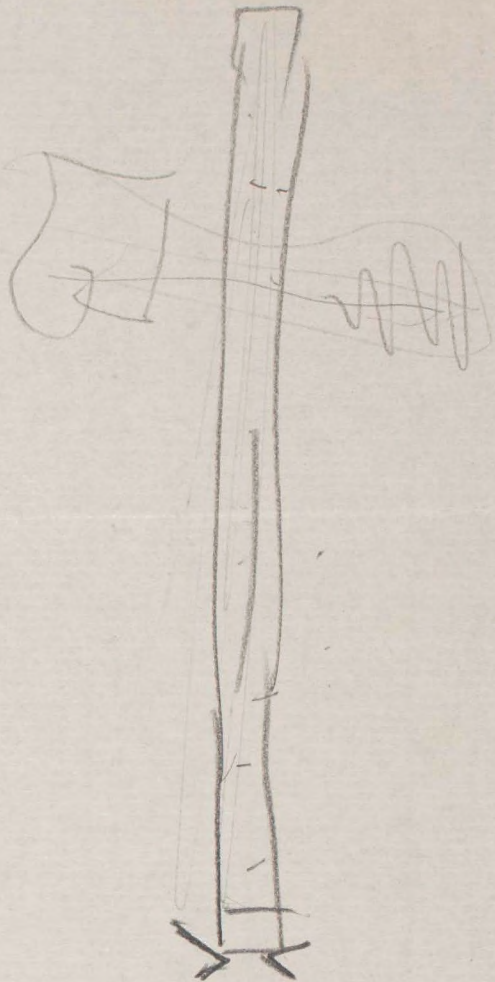
Lincoln

B. Baker

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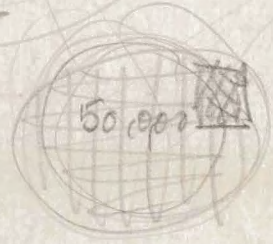
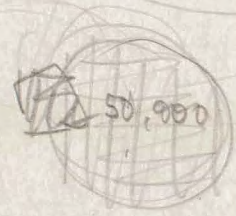
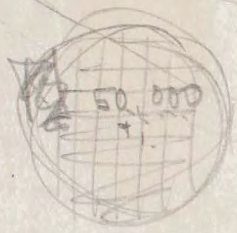
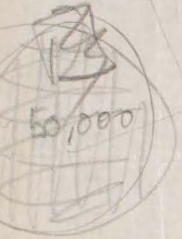
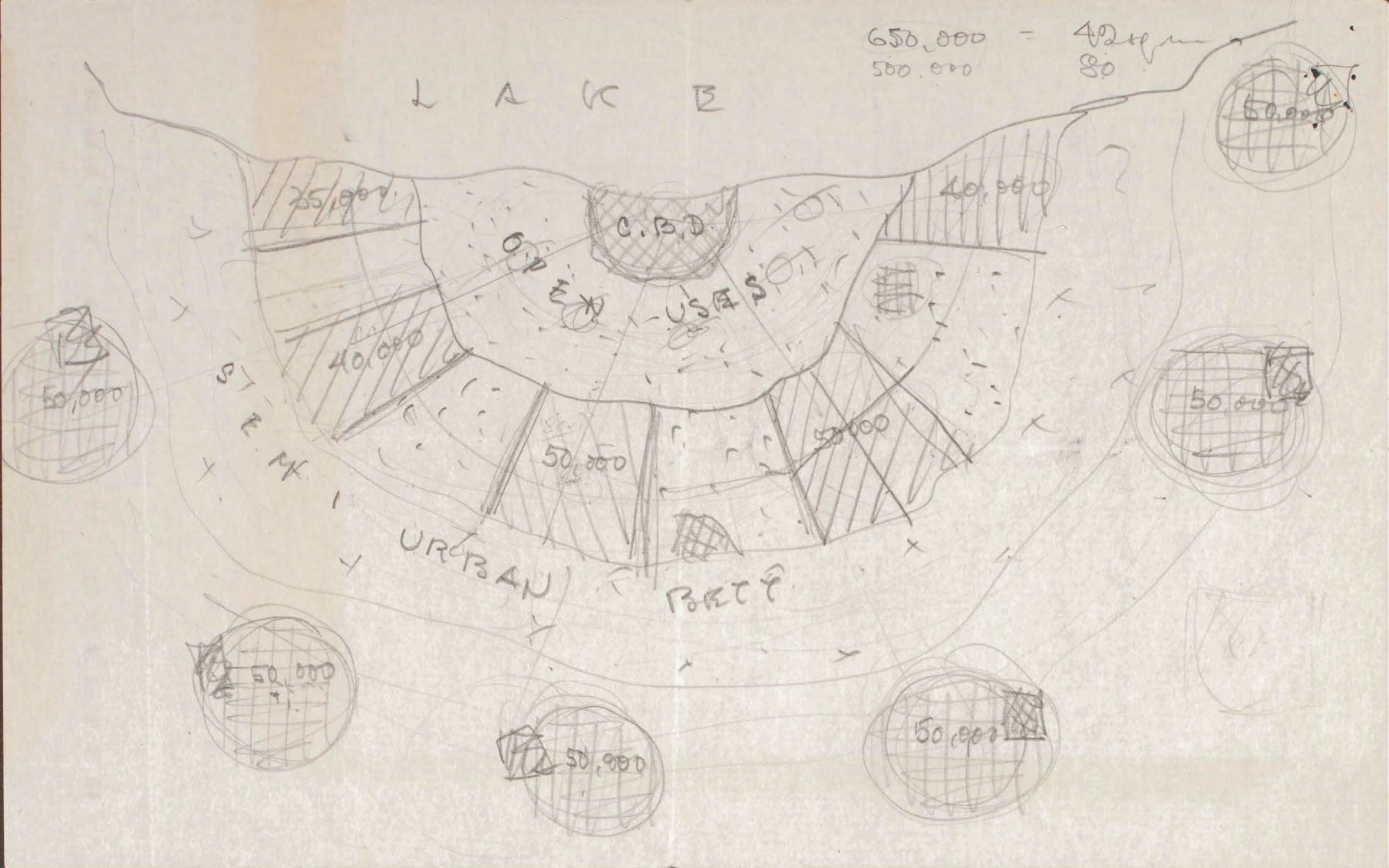
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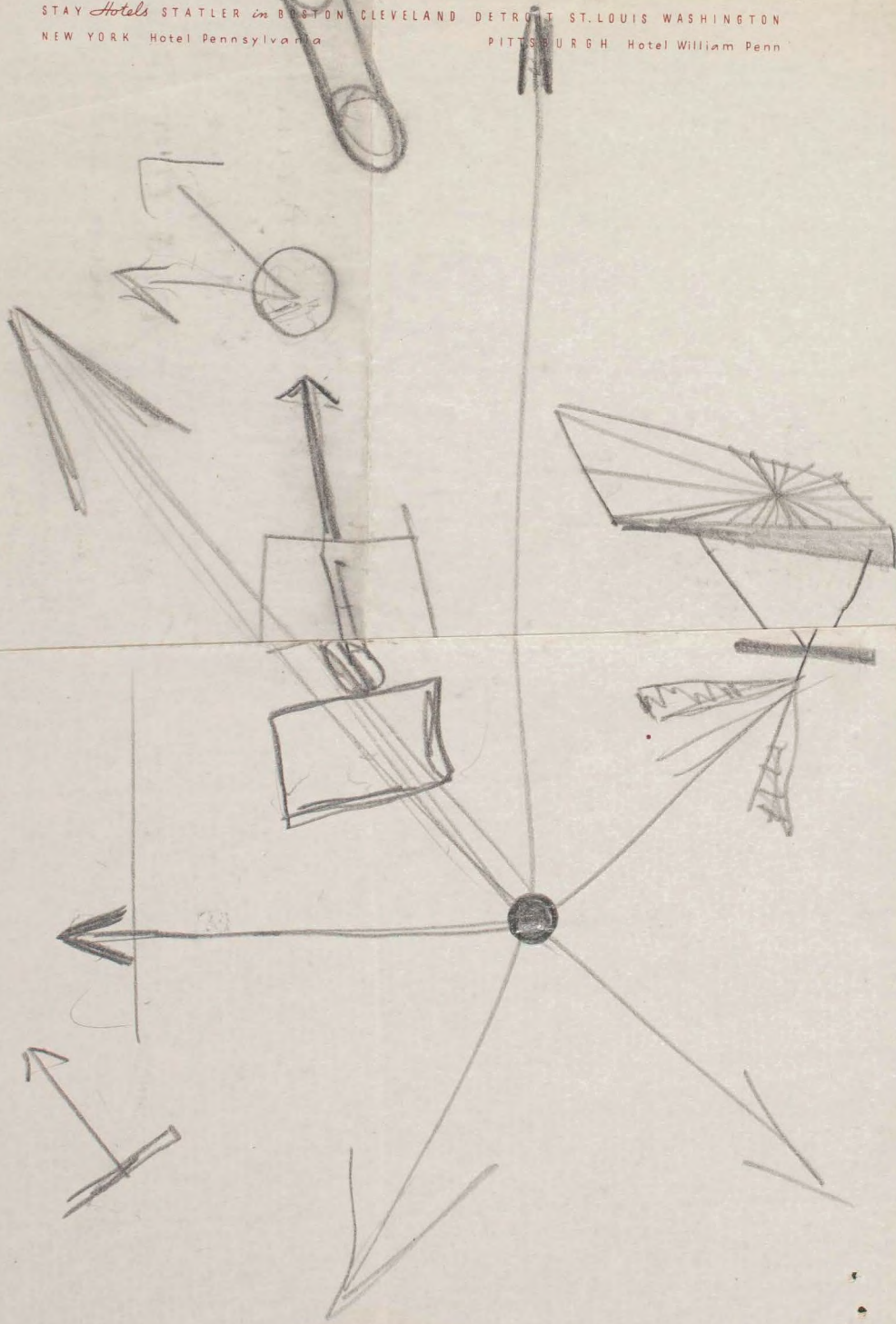
650,000 = 4200
500,000 80

L A K E



HOTEL STATLER BUFFALO

STAY *Hotels* STATLER in BOSTON CLEVELAND DETROIT ST. LOUIS WASHINGTON
NEW YORK Hotel Pennsylvania PITTSBURGH Hotel William Penn



800 Bollwood

X 2500
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90,

Bollwood

per person
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200

Lewis

Blitcher
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much following day

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→ Organ planner
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Elgin, Sta. ... ?

~~Blitcher~~
next school
handwriting of
art.

13 Billion

1927 peak total construction
and maintenance
(private, commercial
public)

\$200 Billion total
real estate (new form)
including grounds (land)
includes 20 Bn. of
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tel + tel

$\frac{1}{2}$ $\frac{110 \text{ Billion}}{10} = 11 \text{ Billion}$

Keypmans

Humboldt
Sound

1655

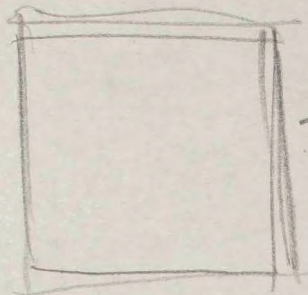
8¹⁰
10¹⁹

Klein

1946

63,000

all metrop. dist
(50 or more)



25,10³

or

1000 per mile

20 Billion

Rents of count. industry

~~15~~ 15 Billion in 1942

— must decrease if you
non produce houses
construct an industry can
handle it.

~~there~~ 50 per miles square
in inhabitable area | $\frac{135 \cdot 10^6}{50}$
= 2,700,000 miles sq

100 notes each

27,000 to cover the
country

JAMES M. ...
BOND
MADE IN ...

The size and shape of cities under atomic bombing.

1. Destruction function: extent of damage done to a building r miles from hit:

$$C_1 \cdot e^{-r^2/2\sigma_1^2}$$

The constant may be chosen so as to make the destruction from a direct hit total,

$$C_1 = 1.$$

2. Aiming function, x' & y' rectangular coordinates from the objective as origin. Probability of hit between

$$\begin{matrix} x' & \text{to} & x' + dx' \\ y' & \text{to} & y' + dy' \end{matrix}$$

$$\text{is } C_2 \cdot e^{-(x'^2 + y'^2)/2\sigma_2^2} dx' dy'$$

the constant being chosen so that the total probability is 1.

$$C_2 = \frac{1}{2\pi\sigma_2^2}$$

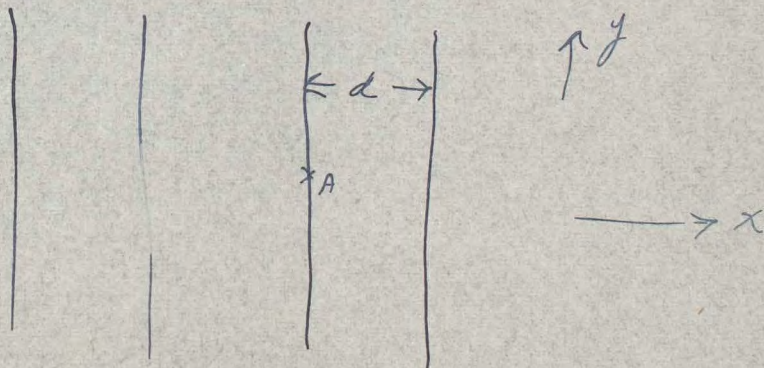
3. Compound ^{function} Functions: Expected extent of damage to a building in position (x, y) with respect to objective

$$C \cdot e^{-\frac{x^2 + y^2}{2\sigma^2}}, \quad \sigma^2 = \sigma_1^2 + \sigma_2^2, \quad C = \sigma_1^2 / \sigma^2$$

Proof: It holds for each dimension separately, and the two dimensions (x and y) are independent (additive in the exponent).

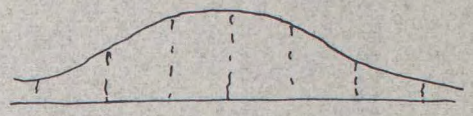
All strategic discussions can be held in terms of σ^2 , it being immaterial which part is due to imperfect aim, which part to radius of destruction (assuming that two buildings half destroyed is as bad as one building totally destroyed).

4. Any departure from complete dispersal is an advantage to enemy as long as σ is finite. The advantage is easily computed in the following cases.
5. Parallel linear cities of infinite length. Distance d .



The enemy aims for a point A on one of the lines. The expected damage done in the y-direction is the same as in the case of complete dispersal. The expected damage in the x-direction is increased in the ratio

$$\frac{\frac{1}{\sqrt{2\pi} \cdot \sigma} \left(1 + 2 \sum_{n=1}^{\infty} e^{-\frac{(nd)^2}{2\sigma^2}} \right) d}{\frac{1}{\sqrt{2\pi} \cdot \sigma} \int_{-\infty}^{\infty} e^{-\frac{x^2}{2\sigma^2}} dx} \equiv D(d)$$

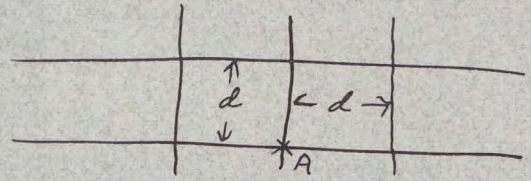


The denominator equals 1.

This ratio indicates the increased destructive power of one bomb through departure from complete dispersal according to this particular pattern. It can easily be calculated for various values of d (preferably all multiples of the same d_0) from a table of $e^{-x^2/2}$

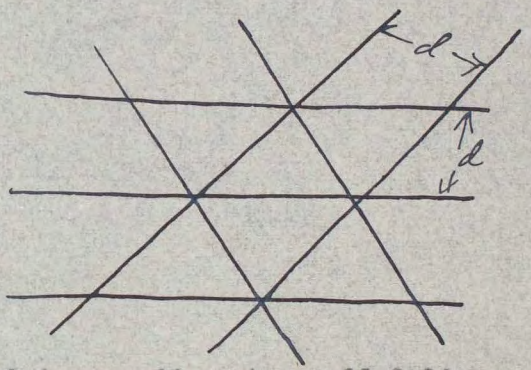
(Approximate sum and integral by $\sum_{n=1}^N$ and $\int_{-\infty}^{\infty}$ N large).

6. Two systems of parallel linear cities at right angles.



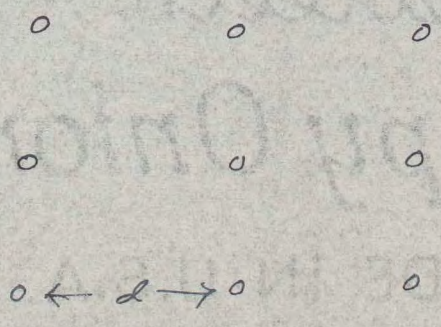
The aim is for a point of intersection. The expected damage is again increased (as compared with complete dispersal) in the ratio $D(d)$. For proof see case 8.

7. Three systems inclined at 60° to each other. Same ratio $D(d)$,



d remaining the perpendicular distance between adjacent parallel lines. Proof: see case 8.

8. Square pattern of point-like cities

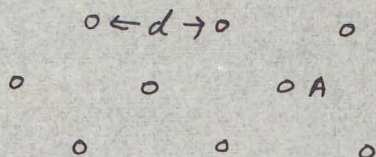


In this case the ratio is $D^2 (d)$

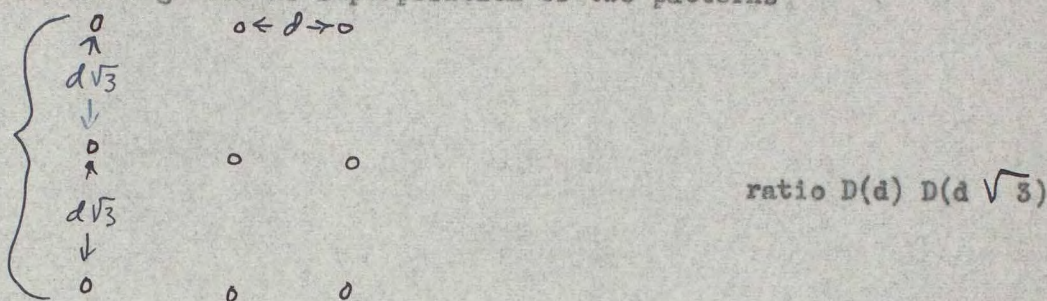
Proof: Case 5 can be said to be obtained from complete dispersal by "contraction in the x-direction" to a discrete set of equidistant x-values. Similarly, case 8 is obtained from case 5 by an additional contraction in the y-direction.

This also explains why in cases 6 and 7 the ratio is as stated and not D^2 and D^3 respectively. In 6 half the houses are contracted in the x-direction, the other half in the y-direction, with the ratio D applicable to each half, and therefore also to the whole.

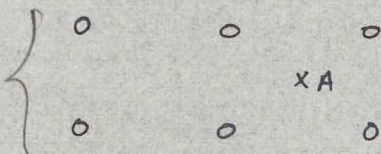
9. Triangular pattern



This can be regarded as superposition of two patterns



and



differing only in the location of the objective aimed at.

Ratio for second pattern:

$$\left\{ 2 D \left(\frac{1}{2}d \right) - D(d) \right\} \left\{ 2D \left(\frac{1}{2}d \sqrt{3} \right) - D \left(d \sqrt{3} \right) \right\}$$

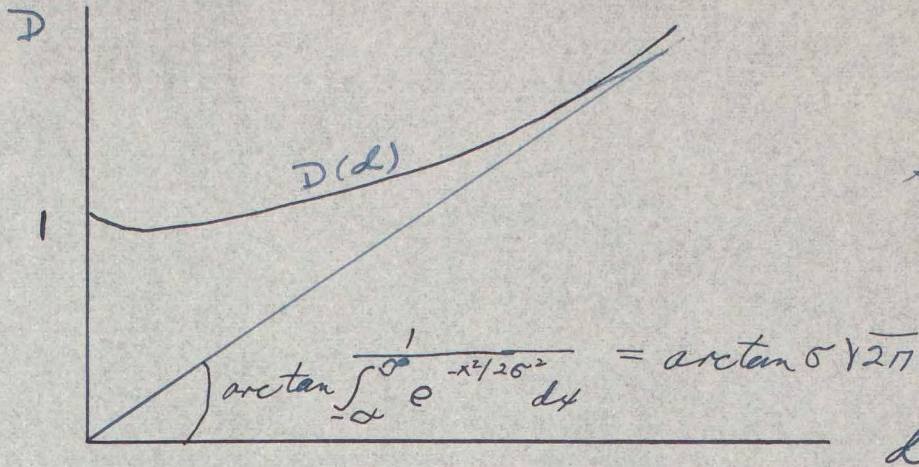
Therefore ratio for triangular patterns

$$D_{\Delta}(d) = \frac{1}{2}D(d)D(d\sqrt{3}) + \frac{1}{2} \left\{ 2D \left(\frac{1}{2}d \right) - D(d) \right\} \left\{ 2D \left(\frac{1}{2}d \sqrt{3} \right) - D \left(d \sqrt{3} \right) \right\}$$

10. In all foregoing cases the area of point-like cities and the width of linear cities has been neglected. Not much is gained by dropping this assumption, except for very large cities.

Gleancopy Onion Skin
Back

11. Shape of the function D(d)



12. It is presupposed in the foregoing that bombing cannot be made more accurate in one direction than in the other. If it can, and if the preferred direction is at the choice of an enemy, linear cities lose in usefulness compared with point cities. If the preferred direction is determined by nature and constant in time, the patterns can be adapted by a "stretch" in one direction only.

Dec. 4, '45
Tjalling Koopmans

Esleek
Clearcopy Onion Skin
MADE IN U.S.A.

Table of D as a function of $\frac{d}{\sigma} = k$

$$D = \frac{1}{\sqrt{2\pi}} \left(1 + 2 \sum_{n=1}^{\infty} e^{-\frac{1}{2} (n\kappa)^2} \right) \cdot \kappa$$

$\kappa = \frac{d}{\sigma}$	D	$\frac{D}{\kappa}$	D^2
0	1	∞	1
.5	1,000		1,00
1.0	1,000		1,00
1.5	1,000		1,00
$\sqrt{3}=1.73$	1,002		
2	1,014		1,03
2.5	1,035		1,18
3	1,222		1,49
$2\sqrt{3}=3.46$	1,355		
4	1,496	$\approx \frac{1}{\sqrt{2\pi}}$	2,24
∞		$\frac{1}{\sqrt{2\pi}}$	

Esleack

Grandonny Onion Skin

$$5 \times 2 \frac{3 \cdot 10^6}{625 \times} =$$

Marchant

50,000 Bunches =
if diameter 5 miles

$$450 = \underline{\underline{200 \text{ Tons}}}$$

15,000 people / city

600 people / mile or 160 hours /
10 blocks for a mile mile

Marchant says 3000 people / square
mile in a big city
assumes 3 miles diameter of address
area 3 miles square = 21,000 people

Andrews

in my city

$$2000 \times 3 = 6000 \text{ people}$$

10 blocks / mile

8 lots / block on one side of
street

one street in Marchant's
city

100,000

50,000 50 miles

2000

$$\frac{20}{6}$$

square miles

13000



Hyde Park 2978
 W.M. 6073
 Plain March

Haarlem (every one over 2500)
\$130 Billion
\$80 Billion for metropolitan
only ~ 63,000,000 (1940) (17,000,000 families)
(average cost of home \$5,000
21 million doubling 74,000,000)

Probably owned plants
\$115 Billion (unremovable) Private

\$45 Billion Highways etc
Public

added for Urban \$290 Billion

MEMORANDUM ON RELOCATION OF CITIES

This brief note is intended to present rough estimates of the real economic burden of completely rebuilding and relocating all the principal metropolitan districts of the United States and other strategic productive plants, in order to acquire as much safety as possible from the effects of atomic bombing. Principal metropolitan districts are defined by the Bureau of the Census to be concentrated areas with a central city of 100,000 or more persons or with a gross population of 1,500,000 or more.¹ It is assumed that any cities in smaller population districts cannot obtain any greater safety by redesign.

There are many costs involved in this program which we make no attempt to estimate. We ignore the psychic costs of a redistribution of property values, a change in established community life, etc. However, once society decides in a democratic way to undertake this vast program, then it automatically follows that the majority of the people consider the psychic gains of strategic safety to outweigh any psychic losses.

We shall split our fixed productive plant into three categories, for convenience, and attempt to measure the cost of replacement of each category. The three classes are the residential dwellings, the fixed plant owned by private enterprise, and the fixed plant owned by the government or other non-profit institutions. All the calculations to follow are carried through in 1934 dollars because that happens to be a benchmark period for many of our data. Since we are interested in the "real" costs, the particular price level which serves as a frame of reference is completely arbitrary and at our disposal.

1. A list of the principal metropolitan districts can be found in the 1940 census volumes on housing.

The total stock of nonfarm dwellings at the end of 1941, our last pre-war year, was about \$60 billion, exclusive of land costs. From the 1940 census data, we find that 71.5 per cent of this stock was located in principal metropolitan districts. Consequently, our relocation program will call for the rebuilding of about \$43 billion of houses.

Of the plant belonging to private producers, some will have to be relocated even though it is not in principal metropolitan districts. The plants in the manufacturing industry and the transportation-public utilities industry are of strategic military importance and will have to be entirely relocated if we are to achieve security. The total plant and equipment in manufacturing and transportation-public utilities, amounted to \$68 billion at the end of 1941. It may be possible to salvage much of the present railway track mileage, and, thus, our figure is a slight over-estimate. In any case, much of the transportation industry will have to be somewhat redesigned to service the newly located factories. The remaining fixed plant and equipment owned by private enterprise is located in the trade, service, and financial industries. These units will not have to be rebuilt if they are located in smaller cities. We have assumed that this plant is distributed between small population centers and principal metropolitan districts in the same proportions as is the case for dwellings. This assumption is probably not far from the truth since the resources of trade service and finance are intended to service the needs of their respective population centers. The fixed plant and equipment of trade, service, finance, and miscellaneous enterprises in principal metropolitan districts is estimated at \$21 billion.

The total plant and equipment owned by private enterprise which will be subject to relocation is thus valued at \$89 billion for the end of the year, 1941. In the relocation process, the equipment can be moved, while the plant

must be rebuilt. From national wealth statistics, we estimate that \$59 billion of the total represents plant and that \$30 billion represents movable equipment.

Finally, we must estimate the fixed plant owned by the government (federal, state, and local) and by other non-profit institutions. The total plant and equipment attributed to this group is measured at \$30 billion at the end of 1941. A small amount of this figure is represented by movable equipment, but not knowing the precise amount of equipment, we treat the total as though it were entirely fixed plant. There is no available information on the proportions in which this plant is divided between large and small population centers. But, a very large part of the federal and state government capital is located in principal metropolitan districts. Again erring on the side of conservatism, we have assumed that all this plant and equipment is located in principal metropolitan districts. This figure is also inflated slightly by the fact that it includes public highways, many of which will not have to be rebuilt.

The total plant to be replaced is thus reckoned at

Residential housing	\$43 billion
Private producers' plant	59
Government plant	<u>30</u>
Total plant	132

The total program should cost us \$132 billion of new construction.

There are other minor costs which may or may not be incurred.

There are demolition costs in case we decide to demolish the abandoned cities. We need not undertake this project immediately, however. There is also the possibility of a slight loss of productive ability while plants are immobilized during the moving period; however, it can be shown that this cost

7

will be very small, less than \$1 billion per year spread over a decade.

We would have to supply additional transportation services to shift the movable equipment owned by private enterprise. This should, however, be a small part of the total construction program. Another financial cost which is not a real burden, is the cost of land. We have the available land; so there is no cost of creating something new. But there is the cost of paying the owners of this land an indemnity in order to make it available for the new cities. This financial transaction can be handled by the federal treasury in a variety of ways and can be left out of consideration here. The extent to which land acquisition would diminish our productive power would be truly negligible.

Finally, there is the cost of replacing depreciated plant with new plant valued at more than the depreciated level of the old plant. The total, above, of \$132 billion is the value of depreciated plant, but we may have to build a plant valued at more than \$132 billion. It would not be practical, in some cases, to replace a three-fourths depreciated plant with a new plant equivalent to the three-fourths depreciated plant. We may have to replace the plant with one closer to the original value of the plant. This would not be done in all cases, though, because it is a pure subsidy to private individuals. Furthermore, the new units would be very superior, technologically, to the old, and we can get a new productive plant at a much lower cost than was expended for an equally productive old plant. We rely largely on the increased quality of new plant to compensate for this added cost which has been neglected.

Can we carry this burden without a decrease in our plan of living? If we spread the program over a decade, it is immediately evident that it is possible to have our new cities and more consumer goods than ever before, in

war or pre-war years. A construction program of \$13 - \$15 billion per year represents much less than one-third of our peak expenditures on munitions and construction during the war. We can, hence, add several billions to our wartime consumption and still maintain this construction program. It would not even be necessary to have a significant shift of resources to the construction industry because it is already large enough to do the job. Wartime construction was about \$11 billion in 1942, the year of greatest construction activity. In a normal peacetime year such as 1929, we were able to carry on construction activity at a level of \$8 billion. Most of our resources that were devoted to munitions production during the war would be released to produce durable consumers goods. Not only would we have a huge aggregate volume of consumption, but also we would have the types of consumer goods that we desire.

There is at least one recent example of the feasibility of this program. Under great duress and with poorer facilities, the Soviet Union was able to move many of her factories to the east. We have no exact data on the magnitude of this effort, but we can be sure that it was not trivial.

We have little doubt that a program of this order of magnitude would contribute measurably towards the maintenance of full employment. The construction activity called for, in addition to our normal volume, would be enough to wipe out most estimates that are currently being made of our potential deflationary gap. The result is that we would have several years of insured prosperity, better homes and factories, and a great deal more safety from the effects of bombing.

L. R. Klein
Cowles Commission
University of Chicago

MEMORANDUM ON DISPERSAL OF POPULATION AND INDUSTRY

I

Dispersal of Cities as a Secondary Defense Against the

Atomic Bomb

The desirability of dispersing population and industries, which has long been considered on other grounds, has been raised anew by the invention of the atomic bomb. In view of the destructive power of the atomic bomb and the consequent vulnerability of large concentrations of population and industries, plans for reconstructing our patterns of settlement and industry in the United States will probably be considered in the near future.

There is the danger that preoccupation with questions of this sort is likely to distract us from consideration of the primary issue, namely the necessity and possibility of controlling the further development, the manufacture, and the use of the atomic bomb on a world scale. There is the further danger that we may be lulled into a false sense of security by the discovery that it is possible and feasible to gain by dispersal a greater measure of invulnerability against the weapon than we have at present and that consequently, we may use less than our total energy to bring the weapon under world control. The mere discussion of this secondary issue of dispersal is likely to have dangerous consequences, for it will tend to make us regard the imperative necessity of finding an effective world organization for the control of the weapon as less urgent and inescapable than it is.

It is well to keep in mind, therefore, that in the discussion of social adjustments to the atomic bomb, first things should come first. And the first thing is the immediate development of an effective world control of the weapon through political means.

Only in the event that the prospect of developing this control is so remote as to leave us exposed to mortal danger should the secondary defense against the atomic bomb in the form of dispersal of our cities and industries be seriously considered as an alternative. The very fact that we are considering this secondary defensive measure may lead other countries to believe that we are not convinced of the inescapable need for world control of the weapon and may intensify resistance on the part of other nations to world organization for this purpose.

If the emergence of a world control organization should be long delayed, it may be necessary, despite the provocation which such a policy might imply, to proceed on a process of dispersal as an interim measure. In that case, time would be of the essence and such a process would have to begin at the earliest possible moment and be carried to completion in the shortest possible time. This would obviously increase the cost and the dislocation involved. Given the fact of the unattainability of an effective world organization, we should want to know from the experts approximately how long it will take before other countries will be in a position to use the weapon against us so as to know into what time-span we will have to concentrate the dispersal. If it were to cost us approximately 15 billion dollars a year over a period of 10 years to carry out the minimum dispersal program, it would cost considerably more than twice that amount to concentrate it into a five-year period, and the dislocation to the economy and the society would be proportionately greater. Even under the incentive of the greatest urgency, we should probably not be able to complete even a minimum program of dispersal in less than five years.

Having called attention to the negative consequences of a program of dispersal, we should not fail to recognize that the determination and publicizing of the tremendous costs of such a program together with the necessary changes in our economy and society which it entails might in itself serve as an incentive to persuade the American public and its leaders of the inescapable need for world control as the lesser of the two evils. If, in addition, it could be made clear that even after a program of dispersal is carried out successfully, we would still only have partial invulnerability against attack, the incentive for America to take the leadership in forming an effective world organization would be even greater.

Advantages of Dispersal

Long before the invention of the atomic bomb, there has been widespread discussion among students of urbanism, city planners, and the enlightened public in this country and other countries of the advantages to be obtained by, and the need for, the devolution of cities and especially of metropolitan districts. Among the items most frequently mentioned as constituting disadvantages incident to the excessive concentration of people and industries in cities were:

- (1) High costs of urban land
- (2) High costs of urban government
- (3) High costs of industrial production in urban areas
- (4) Tendency toward the development of slums and blighted areas
- (5) Traffic congestion
- (6) Unfavorable influences upon marriage, child bearing, child rearing and family life

- (7) Adverse influences upon the development of neighborhoods and local community organization
- (8) Adverse influences upon democratic living; corruption in government; non-participation in the political process, segregation and social and economic stratification.
- (9) High rates of delinquency, crime and social disorganization
- (10) Adverse influences upon health: danger from contagious diseases and epidemics and stress and strain upon the human nervous system.
- (11) Noise, grime and smoke
- (12) Dependence upon employment and economic security without capacity for self subsistence in case of unemployment
- (13) Absence of contact with nature and need for man-made recreational facilities
- (14) Reduction in leisure due to time consumed in moving to and from work
- (15) Reduction in intimate personal contacts and increase in personal frustration
- (16) Vulnerability in case of war especially from attacks by air

While the human and material costs of urban concentration are undoubtedly great, they have been compensated for, at least in part, by the greater economic opportunities, the heightened personal competition, the cultural advantages, the freedom, the stimulation and the psychological magnetism of the city, especially the great city.

Doubt has frequently been expressed as to whether the benefits that derive from modern technology, science, culture, large-scale production and the division of labor could be retained without dense concentration of large masses of heterogeneous people, material facilities, and social institutions in great urban centers. While it has been recognized that diminishing returns in all of these respects set in, once a city reaches a certain size, the optimum size of the city from an economic and cultural standpoint remains to be determined.

As a result of the unfavorable factors associated with living and working in metropolitan cities and consequent upon the development of rapid transportation, the growing cities of the United States have spilled over their municipal boundaries. This development, although it has emptied the core of our great cities of a large proportion of their residents, has not resulted in an appreciable loosening up of the urban structure and constitutes merely a limited decentralization within metropolitan regions. The dispersal we have experienced thus far is merely a trend toward an ever widening circle of suburbs which can exist only, however, as long as there is a central metropolitan city. It is doubtful, for instance, whether the opera, the symphony concert, the great department stores and specialty shops, the press, radio and publishing houses, the great medical centers, hospitals and educational and cultural institutions could exist if it were not for metropolitan centers. There is no doubt, however, that instantaneous communication, rapid transportation and modern developments in social and economic organization make probable the wider dispersal without appreciable loss of the advantages hitherto obtainable only in metropolitan centers.

It is clear that our cities and our metropolitan centers, as they now exist, are far from being the most efficient places in which to live and in which to work. It is also clear that except for the historical circumstances that gave rise to them, a great many of our cities have lost their reason for existence where they now are, and might as well be relocated elsewhere or broken into smaller units. It is also true that our cities were vulnerable to attack even before the invention of the atomic bomb, and that security in time of war has been given increasing attention by planners in recent years, especially with the development of air warfare.

For maximum security against the atomic bomb, however, it should be understood that the recent trend toward suburbanization is not enough, for the suburbs presuppose the continued existence of the metropolitan center virtually in its present form and themselves constitute major concentrations of population and industries contiguous to the central city and to each other. Dispersal adequate for defense against the atomic bomb would require as a minimum, the relocation of existing suburbs over a much wider radius from the city center, and in a discontinuous relationship to one another. The minimum requirement for metropolitan decentralization, therefore, would be the absolute decline of the central city and the development, instead of suburbs, of more distant outlying satellite towns.

The Magnitude and Implications of the Task

There were in the United States in 1940, five cities with 1,000,000 or more inhabitants, nine cities between 500,000 and 1,000,000 twenty-three cities between 250,000 and 500,000, fifty-five cities between 100,000 and 250,000, one hundred and seven between 50,000 and 100,000 population. We had then, ninety-two cities with 100,000 and over

and one hundred ninety-nine cities with 50,000 and more population. Approximately 29 per cent of our people lived in cities of over 100,000.

An even more important measure of urban concentration of the United States is the proportion of population living in Metropolitan Districts¹. The 140 such Districts in 1940 contained nearly 63 million inhabitants or approximately half of the population of the United States. Of these about 43 million lived in the central cities and 20 million in the suburban territory. The war has further accentuated this metropolitan concentration, since approximately three-fourths of the new war plants were located within the metropolitan areas of cities with a population of over 100,000.

The decentralization of population would necessarily have to be synchronized with the relocation of industry, administration and transportation. There are limits set by the location of natural resources beyond which the relocation of industry cannot go without encountering extremely adverse conditions. Similarly there are minimum limits to the size of plants, especially in heavy industry, below which economical operation is questionable. Although dispersal could probably go far beyond its present stage without encountering serious obstacles and, indeed, might be economically desirable, planning to bring about a pattern which would be sound from both a military and economic point of view presents complex national, regional and local problems.

¹ A Metropolitan District has been set up by the U. S. Census (1940) for each city of 50,000 or more (sometimes 2 or more being in one district), including generally all adjacent and contiguous territory having a population of 150 or more per square mile.

What is true of industrial relocation applies equally to transportation. The railroad network of the country constitutes the most important and difficult phase of this problem. In view of the relatively high degree of obsolescence of our present transportation system, however, there might be sufficient incentive other than that of deriving from defense to induce the nation to undertake it.

The development in recent years of vast hydroelectric power projects has already brought about a certain degree of relocation of old, and creation of new industrial areas in hitherto nonindustrialized areas of the United States. The existing power centers and the exploitation of new potential sources of power promise to bring about important interregional shifts in population and industry. Since the advent of the atomic bomb and of the large-scale hydroelectric power development in this country roughly coincide, there should be little difficulty in planning the industrial and urban dispersion in the regions of large new power resources to fit in with the needs for defense against atomic warfare.

The relocation and dispersal of the administrative, commercial, service and institutional centers of the nation would pose problems similar to those involved in the decentralization of industry. These problems would, however, not be insuperable.

Aside from the technological and financial problems which the dispersal of cities and industries involves, we must consider the political, economic and social adjustments incident to such an undertaking. To say the least, it is unlikely that these changes could be brought about in an orderly manner, on a purely voluntary basis. Billions of dollars in property values would be destroyed by the removal of residences, industries, business establishments, and other

facilities from the central cities. The offer of free land by the government in outlying new areas would not compensate for these losses, for the value of urban land consists solely in its location. It should be noted, however, that the loss of property values in urban land would not be a destruction of real wealth, although it would undoubtedly have profound political repercussions.

The losses incident to the shift-over from the existing to the new pattern would also be enormous, although they could be minimized by retaining the existing structure until the new structure is completed.

When we consider the intangible human and social cost of the vast--and yet relatively insignificant--mass uprooting and migration of people and industries during World War II, the prospect of relocating the people, industries and facilities of all cities and metropolitan regions of over 100,000 or even of over 1 million appears staggering.

In order to execute such a relocation plan it would obviously be necessary to carry it out on a national scale. It would probably have to be carried out at public expense and under public control. The minimum requirement of public control would be that residents and industrialists would be told where they could not locate without being told where they must locate. Since the relocation of individual industries, facilities and residences would, however, depend upon the similar or different intention of others, the public control necessary would virtually have to be total and enforceable through law.

Even after the completion of the initial relocation, public control would have to continue indefinitely to prevent the pattern

of settlement and industry from getting out of hand. Public ownership of urban and industrial land would probably be an indispensable prerequisite for accomplishing and maintaining the desired pattern.

The concentration of power in the hands of the national government which such a program calls for, implies a fundamental change in the form of government of the United States which would either require fundamental constitutional revision or the declaration of a state of National Emergency for an indefinite period.

Considering the magnitude, the technical difficulties and the material and social cost of the changes necessary to make the United States invulnerable--or rather relatively invulnerable--against atomic warfare, the conclusion appears to be obvious that it would be far better for this nation to put all of its eggs in one basket by proceeding forthwith to develop an effective world organization for the control of the atomic bomb.

Louis Wirth

APPENDIX A

Taking 1940 Census figures as our base, and assuming that any population center over 100,000 is vulnerable we arrive at the following estimate of the minimum number of cities required to absorb the "surplus" urban population:

City Size	Num- ber	Total Population	Number of new cities of not more than 100,000 each, necessary to absorb population
Places of 1,000,000 or more	5	15,910,866	159
Places of 500,000 to 1,000,000	9	6,456,959	64
Places of 250,000 to 500,000	23	7,827,514	78
Places of 100,000 to 250,000	55	7,792,650	77
TOTAL	92		378

Assuming that each of the cities of 100,000 or more would continue to exist as a city of 100,000 or less, and that the surplus population would be relocated in new cities of not more than 100,000 each, it would require the construction of 378 - 92 cities or 286 new cities to accommodate the displaced population. It is, of course conceivable that, instead of building entirely new cities, the displaced population would be relocated in existing cities of less than 100,000 so distributed as not to exceed the 100,000 mark in any one city. In this manner we could absorb the surplus population without the creation of new cities by merely enlarging and reconstructing the existing cities of lesser size. The suitability of the existing cities for the absorption of the surplus population would have to be determined.

If the optimum size of a city were taken as 50,000 instead of 100,000, the problem of relocation would be modified as follows:

No. of cities 50,000 to 100,000 = 107

Population in cities 50,000 to 100,000 = 7,343,917

No. of cities required = 146

No. of cities required for population of cities over 100,000

$(378 \times 2) = 756$

Total number of cities required $(756 + 146) = 902$

Number of existing cities of 50,000 and over $(107 + 92) = 199$

Number of new cities required = 703

APPENDIX B

The dispersal of cities and the resettlement of population and industries will increase the margin of safety in the face of attack by atomic bombs in the following manner:

- (1) by reducing the number of casualties and the amount of physical destruction that a given number of atomic bombs can cause
- (2) by enabling us (the attacked nation) to retain a greater proportion of our defensive power and giving us more time to employ our offensive strength against the potential enemy

Presumably, for the time being, the number of bombs which can be produced by any one country is limited and through the dispersal of our cities and our productive plant we can increase our chances of preventing demoralization and large scale destruction by sudden attack. Our power to retaliate, if known to the enemy, might conceivably induce him to refrain from attacking us in the first place.

In order to reduce our vulnerability further after dispersal and as a possible alternative to dispersal the adoption of suitable city plans offering the maximum immunity should be considered.

On the basis of published information we cannot as yet be certain of the exact area and intensity of destruction of a single bomb. Nor can we anticipate the prospect of the development of bombs of greater destructive potential. The official preliminary report by Brig. Gen. T. F. Farrell, chief of the American atomic bomb mission, on the destruction wrought in Hiroshima reveals the following:

- (1) "For a radius of one and a quarter miles from the point of detonation, the area was completely pulverized."
- (2) "To a radius of two miles everything is blasted with some burning."
- (3) "Between two and three miles, the buildings are about half destroyed."
- (4) "Beyond three miles, the damage is generally slight, with roof damage up to five miles and glass broken up to twelve miles."
- (5) "Light shelters were caved in, streetcars were derailed and burned, automobiles had the roofs caved in. A fire started in a forest on a mountain four miles away."

The varying degrees of damage inflicted have been graphically presented in relation to the area of the Chicago metropolitan district in diagram I.

It should be noted that if the bomb which ravaged Hiroshima had been dropped in the center of Chicago it would have totally destroyed the entire central business district, the area of light manufacturing, the wholesale district, the warehouses and all of the railroad terminals together with most of the high grade hotel and apartment area in the inner city and the major part of the blighted area. The lesser damage would have extended throughout the entire city and many of its major suburbs.

In the face of such destructive power several alternative types of city structure might appear to be at least in part of defensive use:

- (1) Limitation of the height of buildings to approximately ten floors in the central area and not more than four floors in the residential areas.
- (2) Complete fire-proofing of buildings.
- (3) Abolition of gas and coal as fuel and substitution of electricity.
- (4) Building as large a part of city structures as possible underground.
- (5) Cellular development of cities in the form of discontinuous and relatively self sufficient communities approximately 5 miles distant from each other as indicated in Diagram II.
- (6) Ribbon development of cities of approximately 1 mile in width and of indefinite length as indicated in Diagram III.
- (7) A combination of 5 and 6 above, as indicated in Diagram IV.

In order to transform the present city of Chicago into the form suggested by Diagram III, for instance, it would have to stretch over a length of approximately 200 miles. This would obviously be impracticable. A city of approximately 50,000 population, however, could be planned for residences, industries and services in a one-mile wide ribbon approximately five miles in length. The location of power stations, railroad terminals, industries, residences, business and service establishments in a reasonably efficient functional relationship to each other would not present insuperable difficulties, especially in view of the simplicity of transportation facilities under such an arrangement.

DIAGRAM I



DIAGRAM II

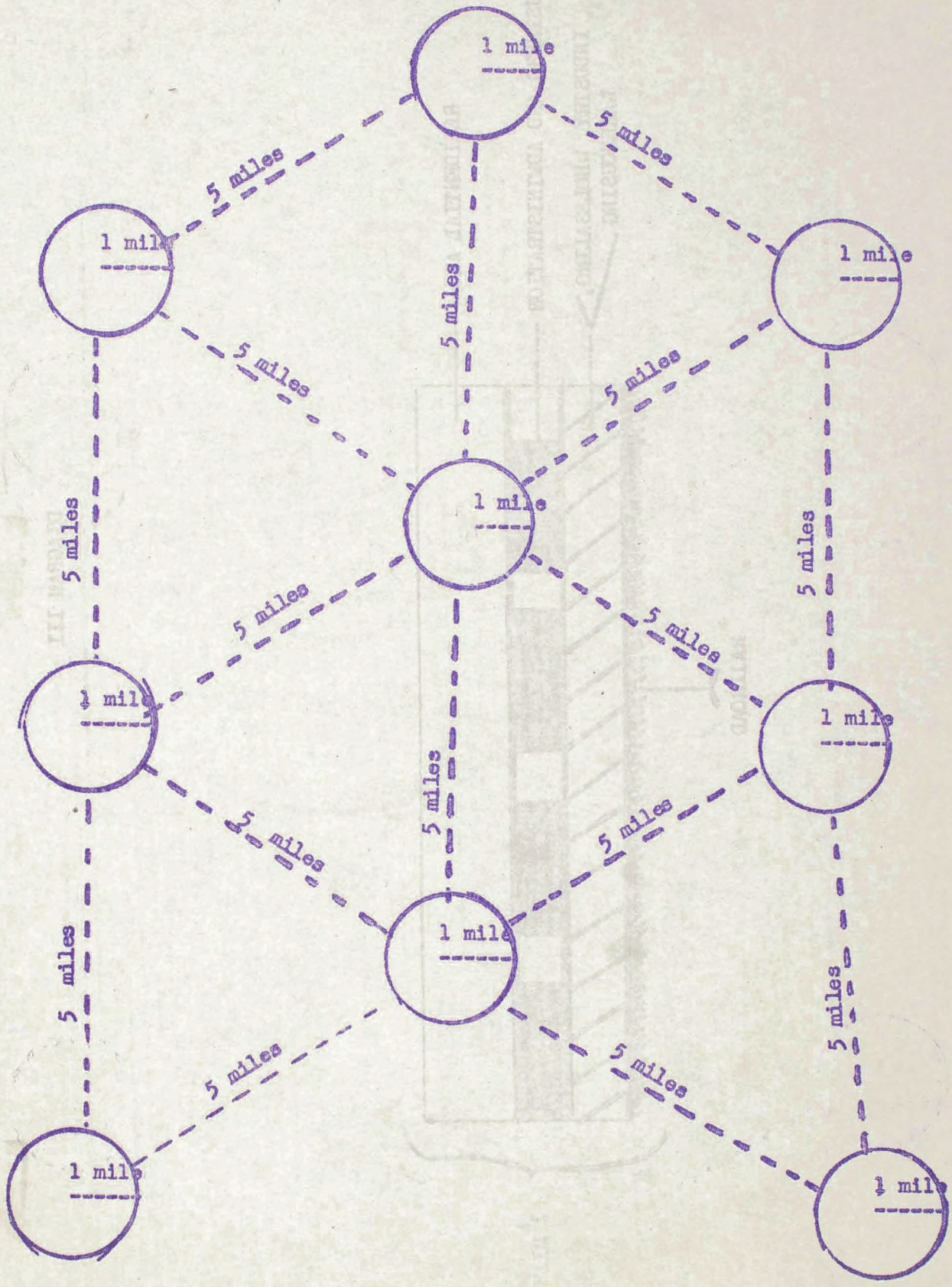


DIAGRAM III

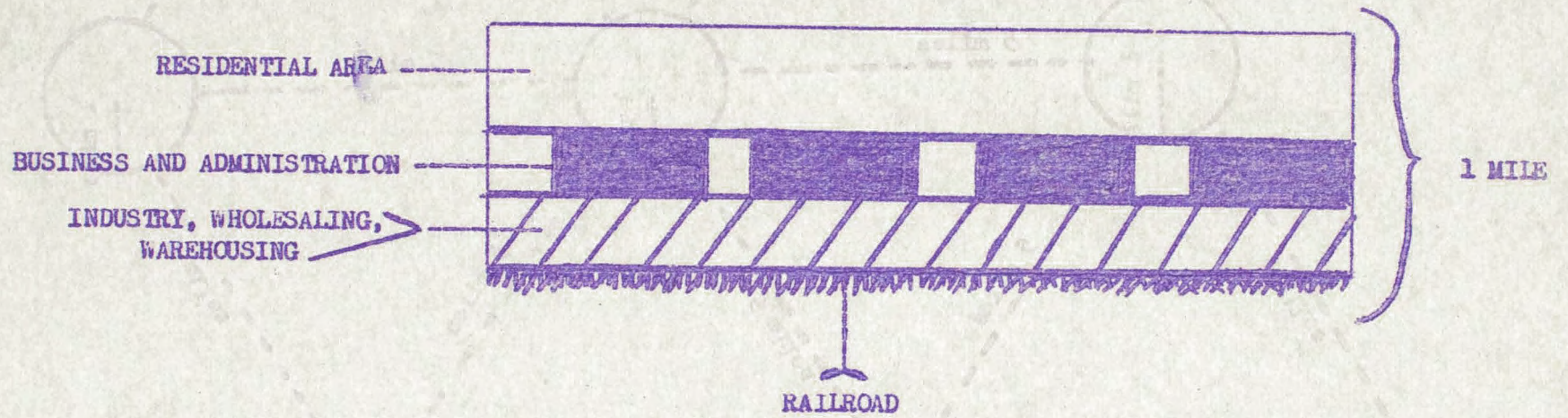
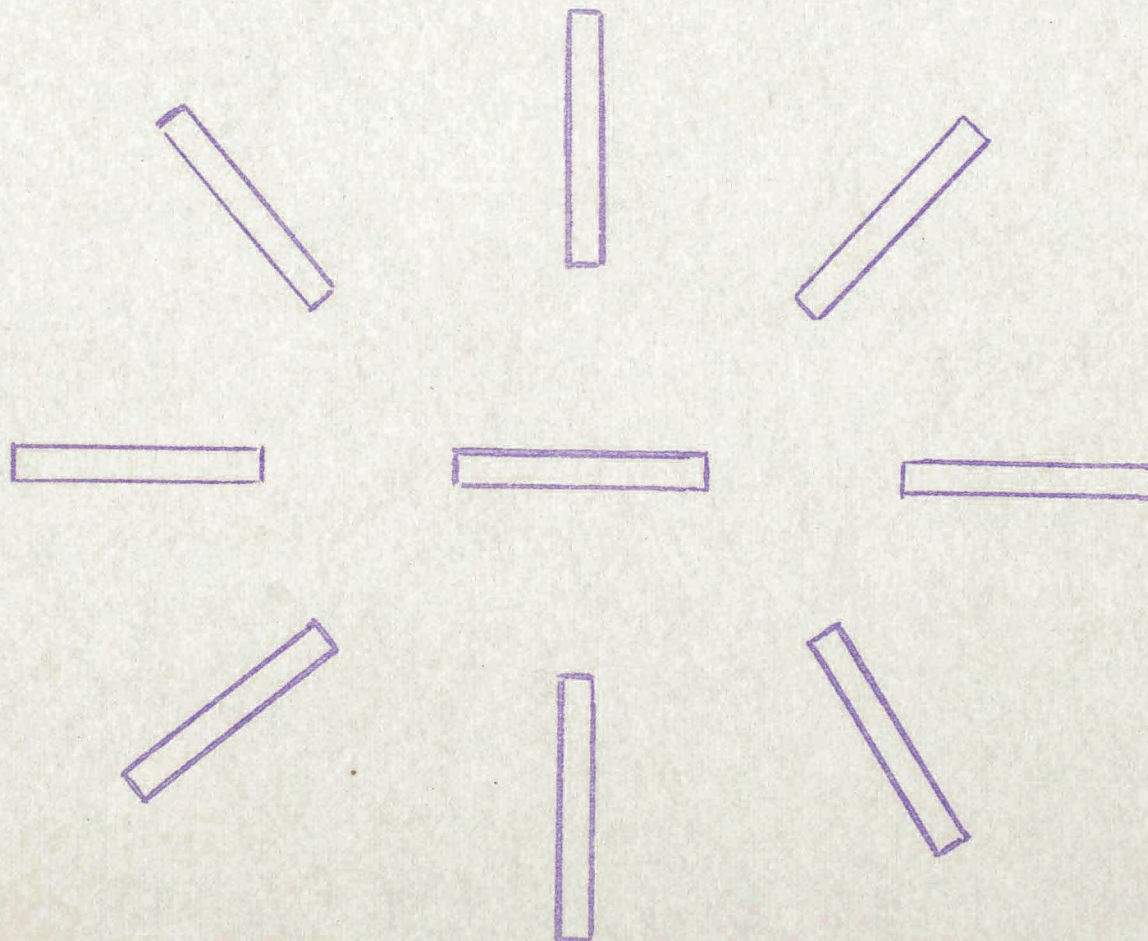


DIAGRAM IV



H. C. Cook

Projet de
Cite Industrielle Belge

invented

Armando Poma
& Mada

"Ciudad Inca"

Compania Mexicana
de Urbanisation

1934

L. Hilberstein
The New City

1944

Pant Theobald - Chicago -