MANUFACTURING PLANT AND RESEARCH CENTER FOR
POLAROID CORPORATION

A Master's Thesis by

Vello Kampman

August 1951

Massachusetts Institute of Technology
School of Architecture
Professor L. B. Anderson  
Head of the Dept. of Architecture  
School of Architecture and Planning  
Massachusetts Institute of Technology  
Cambridge 39, Massachusetts

Dear Professor Anderson,

In partial fulfillment of the requirements for the degree of Master of Architecture, I submit my thesis study on "Manufacturing Plant and Research Center for Polaroid Corporation."

Very truly yours,

Vello Kampman
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"A basic long-term aim of POLAROID is to provide means for all its employees to have a full and complete working life."

This policy statement made by the President of the POLAROID CORPORATION signifies the new trend of thought in the modern industry.

It has departed from its previous concept of producing a marketable commodity just for profit. Apart from its more complicated and numerous activities, in scientific research and production, it regards itself now as a co-operative element in the society.

The architect should be able to meet the demand of the modern industry. To relate the production, social and human needs: flexibility for dynamic changes, physical and spiritual welfare of the workers, and above all creating a pleasant and cheerful environment.

It is this environment where millions of human beings spend most of their precious and active hours of the day.
SYNOPSIS

It is the purpose of the thesis to study the planning of a manufacturing plant and a research center for Polaroid Corporation in a new location.

It is not the objective of this study to arrive at one particular and final solution, but rather to study the factors that influence the design at different stages of development, crystallize the limitations on the chosen site and to investigate a maximum development possible within the scope of reasonable limitations and healthy architectural composition.
The POLARGID CORPORATION came into existence as a result of inventions that made controls of polarized light available on a widespread basis for the first time. With a group of associates, Mr. Land, the investor of this process, started manufacturing polarizing sheet in a small research laboratory in Boston in the early thirties. As an outgrowth of this laboratory, Polaroid Corporation was founded.

As its engineers developed efficient methods of manufacturing the sheet, and the research men found new applications, the company established itself to a growing enterprise. By 1937 it was producing: polarizing camera filters, Polaroid sunglasses, three-dimensional Polaroid color movies, Polaroid glareless headlight system but yet not adapted by the automobile industry. The business increased to such an extent in 1941 that the company had to lease a bigger building in Cambridge. At that moment it had already 200 employees.

With the outbreak of the war, the company underwent an important change. Following the pace set by its teams of research men, Polaroid converted to the invention, development and manufacture of war products involving the
use of polarized light. Simultaneously it broadened its activities of research and production to non-polarizing materials and devices. Most significant of the achievements was in the field of organic chemistry, the synthesis of quinine.

The business boosted to 16 times its prewar level, employing more than 1200 persons in five different plants.

The end of the war in 1945 brought the company back to its peacetime activities. The emphasis was again on basic and applied research. Twenty-seven per cent (27%) of the income was derived from research contracts alone.

In 1946 plans were made to build a new plant in Cambridge, 57,000 sq. ft. of production area in the first stage, and to extend it in the future to be a three-story building with an adjoining six-story research and administration building. The new postwar products did not come into production as anticipated. The idea of building had to be postponed for better business conditions.

The third great development in the companies history resulted in 1948 with the invention of the Land Camera - a dry photographic process that produces finished positive prints in sixty (60) seconds directly from the camera. Hailed by the scientific world as one of the ten most significant inventions of the year, the camera made a
a sensational hit on the market. Since then it has become the company's main activity. The camera is subcontracted presently, the films are produced and assembled in the company's Ames stress plant. A new department of phot-copy resulted from this activity. At present it is the only service to duplicate the pictures for the Polaroid Land Camera owners.

The camera and film sales are increasing from month to month. A great boost is anticipated soon, when a new model of the camera is offered for sale. It is smaller in size and much cheaper in price and operation than the present model. In addition new products are introduced for production: X-ray film.

Continuously new products and ideas are developed. The production of them can start on a decision.

The most advanced prospects are:

- Camera production; that would bring the company into the field of finemachanics.
- Polaroid headlight system; as soon as accepted.
- Radiation detector.
- Three dimensional photographs; after some more research.
SUMMARY OF REASONS AND OBJECTIVE FOR BUILDING

Polaroid Corporation leases all its space at the present time in five different places in Cambridge. As soon as one of the new activities will get under way, the present facilities will be inadequate to manufacture properly.

Reasons for building a new plant are numerous:

- Increase in production;
- Consolidation; Activities could be coordinated, operations becomes more efficient
- Ownership; and economic uncertainties of lease is eliminated, improvements
- Adaptability; and maintainance become your benefits.
- Building is planned around the process and to suit own needs.

"Every building should be a living organic structure, an expression of the policy and integrity of the people who work in it.

It must be efficient and economical to operate. It must be well formed, honest and articulate in its physical expressions and it must satisfy the human beings who occupy it.

It must be extremely flexible, for who know the future."
PLANT LOCATION

Proper plant location is one of the causes in the success of an enterprise. Once the location is selected it is assumed that the industry will continue in this place for a considerable time. Moving is difficult and costly. Decisions must be made very carefully.

GEOGRAPHIC LOCATION

Certain fundamental factors enter into the solution of every plant location. The weighing of these factors, and establishing the relative importance of each assists most in drawing scientific conclusions and deciding the proper location.

Primary factors-
Markets; foreign, domestic, national, local.
Raw materials; principal, secondary.
Transportation; rail, water, motor truck, airplane.
Labor; skilled, unskilled, male, female.
Power; coal, fuel oil, electricity.

Secondary factors-
Climatic requirements,
Public utilities,
Dependency on municipal environment,
Dependency on municipal laws and ordinances.
Advertising value of the plant.
Financial aids, and miscellaneous.
The POLAROID CORPORATION's present location is Cambridge, Massachusetts. In case of movement, the Corporation would like to stay in the Metropolitan area of Greater-Boston.

This for many reasons:-

Polaroids principal products, films, cameras and polarizers are independent of any local market. Boston provides good transportation facilities. Principal raw materials supply comes from the New England region.

Being a fairly young enterprise, it depends basically on research, and Boston is a very convenient location offering servised by its scientific and cultural insti-

It is a favourable location to obtain scientifically trained personnel.

Boston's big labor market offers great number of skilled workers for the operation of the plant.

Polaroid's present staff is firmly established in Boston.

One very unfavourable fact is that a location close to a big city like Boston makes the plant very vulnerable to atomic bomb attacks. The federal government is urging the industry to move away from such big centers.
LOCATION STUDY FOR BOSTON

A plant location in the southwest-northwest quarter of Boston appears to be most desirable.

Employee distribution map indicates that the residences of the staff are situated greatly in the north western part of Boston.

Distance is close to the center of population density.

A suburban location is most desirable for a medium-sized plant. It has all advantages of city location; labor supply, shopping facilities, public utilities, vicinity to allied industries and research centers.

A suburban location has also the advantages of a rural location: lower taxes, room for expansion is more available, better living conditions are offered for the workers, land cost is cheaper. If good highway system is nearby, that is a desirable location to have.
PROCEDURE OF SITE SELECTION

Review of the Companies Needs

Past performance: review the company's background.

Present conditions:
The space committee of the company investigated the present physical facilities, space requirements.
First for the current needs, then for the years to come.
That was done on the basis of the present line of products, and a very conservative outlook into the future in that line only.

The sales and production are predicted to increase.

To meet the demand for additional space, several alternatives are open:

If no substantial growth is in sight the company could continue to get new space in Cambridge. That is the economic solution for the time to come.
No doubt, the operation of a relatively small company in scattered locations leads to inefficiencies, although it is very difficult to measure that quantitatively.
If a substantial growth is to occur, the company would have to look one way or the other for new coordinated plant facilities.
Future forecast:

Manufacturing space needs:

100,000 sq. ft. in the next 2 years
270,000 sq. ft. in the next 3 years.

Land requirements are at least 21 to 15 acres.

It is not feasible to purchase rather expensive land now to hold for future expansion, because of heavy tax charges over the years for the unused portion. But provisions must be made for future purchases or options of land adjacent to the property.

Growth is estimated here only from the increased sale of film products.

To emphasize it; the estimate does not include the possibilities of increase in other products and as well the new lines of products. It is very possible that each of these departments can impose space needs double or even triple to the conservative forecast. The company is very dynamic—flexibility is the keyword in planning.
SURVEY OF POSSIBLE SITES

The quantity and quality of industrial land within the metropolitan area largely limited due to: zoning restrictions, building code restrictions, poor soil conditions, topography inadequate transportation facilities, commuting problems because of the distance from the labor market, high prices.

The company located 28 sites in the proposed area. But only two sites could satisfy the most urgent requirements.

Site #25 in Waltham.
Site #14 in Watertown.

The Watertown site presents some difficulties in site development in form of immense earth fill.

The Waltham site is the first choice.

EXHIBIT D

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<tr>
<th>Site #</th>
<th>Town</th>
<th>Approx. Acreage</th>
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<tr>
<td>I.</td>
<td>Needham</td>
<td>26</td>
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<tr>
<td>II.</td>
<td>Needham</td>
<td>12</td>
</tr>
<tr>
<td>III.</td>
<td>Needham</td>
<td>32</td>
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<tr>
<td>IV.</td>
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<td>20</td>
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<tr>
<td></td>
<td>(Framingham map)</td>
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</tr>
<tr>
<td>V.</td>
<td>Lexington</td>
<td>23</td>
</tr>
<tr>
<td>VI.</td>
<td>East Sudbury</td>
<td>20</td>
</tr>
<tr>
<td>Site #</td>
<td>Town</td>
<td>Approx. Acreage</td>
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</tr>
<tr>
<td>VII.</td>
<td>Wilmington</td>
<td>13(\frac{1}{2})</td>
</tr>
<tr>
<td>VIII.</td>
<td>Woburn</td>
<td>28</td>
</tr>
<tr>
<td>IX.</td>
<td>Concord (Maynard map)</td>
<td>108</td>
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<td>X.</td>
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<td>XI.</td>
<td>Natick</td>
<td>40</td>
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<td>XII.</td>
<td>Natick</td>
<td>31</td>
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<td>XIII.</td>
<td>Brighton</td>
<td>10 (plus 10 refused by Newton)</td>
</tr>
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<td>XIV.</td>
<td>Watertown (Bemis Dump)</td>
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<td>XV.</td>
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<td>XVI.</td>
<td>Watertown (Dump)</td>
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<td>XVII.</td>
<td>Stoneham</td>
<td></td>
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<td>XVIII.</td>
<td>North Cambridge</td>
<td>5-2-8</td>
</tr>
<tr>
<td>XIX.</td>
<td>North Cambridge</td>
<td>6(\frac{1}{2}) plus 2</td>
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<td>XX.</td>
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<td>XXI.</td>
<td>Reading</td>
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<tr>
<td>XXII.</td>
<td>Cambridge</td>
<td>20</td>
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<tr>
<td>XXIII.</td>
<td>North Cambridge</td>
<td>11 plus 5-2-8</td>
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<tr>
<td>XXIV.</td>
<td>Waltham (Jones)</td>
<td>25</td>
</tr>
<tr>
<td>XXV.</td>
<td>Waltham (Edison)</td>
<td>12(\frac{3}{8})</td>
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<td>XXVI.</td>
<td>Riverside</td>
<td>10 at least</td>
</tr>
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<td>Arlington</td>
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<td>XXVIII.</td>
<td>Lexington</td>
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For each site under consideration it is advisable to obtain detailed information, documents and maps:

1. Overall map: it should show the relationship of the site to the neighboring city, overall transportation system, highways and railways.


3. Topographical survey map of the site.
   a) National Geodetic map of the neighborhood
   b) Contour map of the property.

4. Subsoil information, boring data.

5. Zoning map and ordinances of the community.


7. Aerial photographs.

8. Master Plan showing the proposals of the local, county, and state planning boards - especially with respect to roads and highways.

9. Maps and data on existing utilities showing sizes, sources and capacities.

10. Rate schedules for a) water
    b) gas
    c) electricity

11. Photographs of the neighborhood and property.

12. State labor regulations.

13. Property deed investigation.
LOCATION AND TRAFFIC

Site No. 25 under consideration is located on the west side of the city of Waltham, which is one of the communities situated to the extreme west of Metropolitan Boston. The property is bordered by the newly constructed circumferential superhighway, which provides excellent access to all highways leading to and from the center of Boston. The property is strategically located at the junction of three main highways, namely,

- Route 128 - Circumferential superhighway
- Route 20 - Boston Post Road to Springfield
- Route 117 - Highway to Leominster.

This fact is very important in that it provides convenience in commuting for the workers.

SIZE

The proposed site of the 12½ acres is being purchased from the Boston Edison Company, which operates a transformer station on the property south of the site. The Edison Company plan for three additional stations along the railroad tracks as the need for them arises in the future. The size of the property is rather small for building a one-story plant. For a multistory development it would be adequate for present needs but additional land must be acquired soon to provide space for parking and proposed outdoor recreational facilities. The possibilities for expansion must be considered at the very beginning.
Expansion to the north and south would add about 9 acres of suitable land. Final total would be 21½ acres. That makes it almost two times the original size.

SHAPE

The shape of the site is rather unfortunate. Irregular, too narrow and long in its final shape. The distances become too long from border to border. The ideal shape is a regular square or rectangle with good railroad connection and small distances between the parking areas and the plant.

TOPOGRAPHY

The site is mostly level, good for development, although some earth movement will be necessary. No big tree removal is involved. The topsoil is excellent, the present meadow growth is rich. Subsoil conditions allow construction of heavy buildings. Boring results indicate an average refusal at 10 feet below the ground, the watertable at 4 feet below. Drainage is an important problem here to be taken care of.
NATURE OF THE SURROUNDING LAND

The site is located in a narrow valley. The surrounding land as well as the property have a rural character. Wood covered hills rise steep up toward east and west from the meadows in the valley creating a dramatic panorama. The passing motorists will have a birdseye view down on the future plant from the new highway, situated thirty (30) feet above the site level. Nearest residential settlement starts about 700 yards towards east. The air is clean, free of any dust. The temperature is summer is always cooler than in Boston. Very favourable for not air-conditioned buildings. Prevailing summer breeze comes from south-west, in winter from north-west.

ZONING

The municipality welcomes the industry if it does not disturb the community with nuisance. For mutual advantage the property will be re-zoned from Residential B. to Industrial A, hence the surrounding made desirable to both parties. The beautiful nature in the surrounding will be preserved, because the steep, wooded hillsides are too difficult to develop. It is generally desirable to control by purchase the land opposite the main entrance to avoid unpleasant building along the street.
TRANSPORTATION

A railroad siding can be moved in from the Boston & Maine Central Division Railroad which is running south of the property. The turning radius should not be smaller than 360 feet, and the maximum gradient not bigger than 1.5%. Distance to the passenger and freight station of Waltham is 0.7 miles. Good express service is essential. The location is excellent for truck transportation. Trucks do not have to pass through congested traffic areas and can emerge on three main numbered highways; #128, #20, #117.

The site will be served by bus transportation.

UTILITIES

Water, gas and sewage mains are located on the main street and within 1000 feet from the property. Use of utilities by the manufacturing processes are rather limited. The present capacities and provisions are adequate. Storm sewer will be disposed into the nearby brook.

Electricity: Power can be drawn from the adjacent Edison Company transformer station at 13000 volts. The Polaroid Corporation will have to build its own transformer house to supply power at the proper voltages.

Fireprotection: The nearest fire station is located within 0.7 miles at the city center and it is owned and operated by Waltham municipality.
LABOR

The research and administrative staff comprising 1/3 of the company's employees, at present lives for the most part in the suburbs. They come to work by car and will continue to do so in the future. An efficient carpool organized by the employees allows for many more to commute. The number of employees is expected to rise from the present staff of 500 to 1250 in the next two years and to over 5000 in the next five years. Polaroid considers that it will be able to attract sufficient labor from the vicinity:

The wages are high above average.

Waltham has some surplus labor and precision workers due to the recent reduction in Waltham Watch Company.

A job nearer to home would attract those who commute to Boston for work.

Finally, every new factory creates additional labor force in its surrounding.

Industries in Waltham are diversified. Main activity is in the production of electrical products, machinery and apparel.

THE COMMUNITY AND THE LOCAL GOVERNMENT

Waltham is mainly a residential suburb of approximately 80,000 inhabitants. The density is fairly low, the housing facilities are good. Rent levels are lower than
in Boston. The suburban character and the attractive surrounding nature make Waltham a desirable and healthy place to live. Workers welfare and morale depend largely on his living condition. Waltham has a strong mayor form of government. The administration is probably fairly efficient for in the face of rising costs of municipal services the tax rate has been reduced in the last two years to a rate of ______.

The physical environment of the city in term of schools, hospitals, libraries, churches, parks, playgrounds and other recreational facilities are comparable to the better communities of metropolitan Boston.

The city administration is receptive to encourage a varied industrial set-up.

In conclusion, the choice of the site with regard to the community and strategic location, is quite desirable for building the new factory.
POLAROID CORPORATION

1. PRODUCTION
1. Film Production (con't) 1.
2. Polarizers
3. Glass & Plastics
4. Photo Copy
5. Temporary Production Equipment

2. WAREHOUSING
1. Receiving
2. Shipping

3. MAINTENANCE & PLANT ENGINEERING
1. Power Plant
2. Air Conditioning
3. Engineering Drafting
5. Work Shops
6. Stock Rooms
7. Storage of Old Machinery
8. Offices
9. Motor Pool
10. Transformer Station

4. RESEARCH & ENGR. DEVELOPMENT
1. Basic Research
2. Engineering Development
3. Special Products
4. Patent Department

5. ADMINISTRATION
1. Administration Offices
2. Auditorium and Display

6. EMPLOYEE FACILITIES
1. Cafeteria
2. Lounges & Recreation
3. Employees Lockers and Washrooms
4. Parking & Gate

ACTIVITIES
1-A. Chemicals Mixing
B. Film Coating
C. Film Assembly

2-A. Plastic Polarizers
B. Glass Polarizers

3- Optical Production
4- Photo Copy Service

FOLLOW PRODUCTION

5-A. Carpenter Shops
B. Plumbing Shops
C. Electrical Shops

6- By Trades

7- Machinery & Equipment.

1-A. Laboratories 1) Chemical 2) Physical
C. Storage
D. Special Projects
E. Offices

2-A. Design Drafting Rooms C. Spec. Laboratories
B. Model Building Shop D. Quality Control Dev.
E. Offices

3-A. Pola Color E. Offices
B. Three-Dimensional Products (film & movies)

4-A. Law Offices
B. Conference Room Library.

1-A. Administration, General
B. Sales
C. Purchasing
D. Accounting
E. Personnel
F. Public Relations.
**EXHIBIT A**

**ESTIMATED SPACE NEEDS BY YEARS**

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<th>1954</th>
<th>1955</th>
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<tr>
<td>Film</td>
<td>20,190</td>
<td>30,280</td>
<td>50,490</td>
<td>73,650</td>
<td>107,710</td>
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<tr>
<td>Photocopy</td>
<td>3,500</td>
<td>7,000</td>
<td>10,500</td>
<td>14,000</td>
<td>14,000</td>
</tr>
<tr>
<td>Polarizer</td>
<td>11,800</td>
<td>11,800</td>
<td>14,160</td>
<td>14,160</td>
<td>16,990</td>
</tr>
<tr>
<td>Plastic Optics and Glass Shop</td>
<td>5,400</td>
<td>5,400</td>
<td>5,400</td>
<td>5,400</td>
<td>5,400</td>
</tr>
<tr>
<td>Warehouse (Shipping and Receiving)</td>
<td>14,750</td>
<td>22,125</td>
<td>36,875</td>
<td>53,100</td>
<td>78,175</td>
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<tr>
<td>Office and Administration</td>
<td>7,000</td>
<td>10,500</td>
<td>17,500</td>
<td>26,200</td>
<td>37,100</td>
</tr>
<tr>
<td>SX 70 Eng. and Laboratories</td>
<td>23,470</td>
<td>23,470</td>
<td>33,470</td>
<td>33,470</td>
<td>33,470</td>
</tr>
<tr>
<td>Research</td>
<td>13,000</td>
<td>15,000</td>
<td>18,000</td>
<td>21,000</td>
<td>24,000</td>
</tr>
<tr>
<td>Mechanical and Plant Engineering</td>
<td>11,305</td>
<td>15,000</td>
<td>17,000</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Services Areas</td>
<td>11,000</td>
<td>14,000</td>
<td>21,000</td>
<td>26,000</td>
<td>33,000</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>121,415</td>
<td>154,575</td>
<td>224,395</td>
<td>286,980</td>
<td>369,845</td>
</tr>
</tbody>
</table>

All areas are in square feet.
MASTER PLANNING

Planning is applying your logic, knowledge and common sense to each particular problem.
It is a trial and error method, preparing several solutions, and choosing the best. Errors should be made only on paper. The plant development will proceed according to the needs as they arise. The layout and design must allow for radical expandability and inter-changeability. To achieve these objectives certain principles have to be followed:

1. Number of building types should be reduced if possible.
2. Uniformity in units.
3. Standardization in planning and design.

Through an integrated design it should be possible to create and effect of finish and completeness at each stage of the development.

Poloroid Corporation as any other industrial enterprise has innumerable activities. For purpose of better understanding the list includes only the main elements of its operations.
1. Production

2. Research laboratories

3. Engineering development

4. Administration

5. Plant engineering

6. Employee facilities

The main units must be properly situated:

1. In relation to the means of access to the site, the transportation, the traffic and circulation.

2. In relation to each unit.

3. To enable each unit to function well by itself.

**PRODUCTION DEPARTMENTS**

The type of building for manufacturing purposes is determined by the production process, but restrictions imposed by building ordinances, shape and size of the lot, etc., must be observed and may determine the final solution.
The lot is much too small to allow the building of a one-story plant, which would well suit the process and handling methods for film production. The film products and the raw materials are not very bulky and heavy, so a convenient layout can also be developed in a multistory building. The zoning ordinance restricts the building height to four stories or eighty feet. Four (4) stories is also the limit for a walkup circulation scheme for the workers. The final solution therefore consists of four floors of production parallel to the four floor high warehouse. The materials will be handled by elevators and a system of conveyors.

The shape of the building is determined by the production process. Generally a square shape provides a good solution:

1. It is very flexible and adaptable for changes
2. A square building is most economical to build structurally.
3. Since the plant will be air conditioned, the square shape is most economical.
4. Maintenance costs are lowest.

**ORIENTATION AND LOCATION**

The way raw materials enter and the way the finished products leave the plant will determine the general layout of the plant. The goods will be delivered by means of railroad and trucks. The best position for the railroad siding is along the eastside of the property in north-south
direction. That determines the positioning of the warehouse and as well the whole manufacturing plant. From the point of view of air conditioning east-west direction is best but a square shaped building becomes independent of that factor. The trucking road runs parallel to the railroad and in order to reach the Main Street in the shortest time, a new bridge must be built over the Boston & Maine Central Division Railroad line. In this plan the different types of traffic should be isolated. All transportation will enter and leave through the rear of the property, hence the research and administration areas will not be disturbed by the noise of the trucking.

ENGINEERING AND ADMINISTRATION

The type of building used for research, engineering development and administration is fairly similar except for specialized utilities and services. All these activities can be united in one building planned it under a universal module. This solution provides for flexibility of interchange between departments in case of minor expansions. Each department will still operate undisturbed as a homogeneous unit.
Research and engineering departments must be near to the production department since the manufacturing is still in a stage of a pilot plant. The research men often have to try out their inventions with the manufacturing machines..... So the research building is located close to the production plant on one side and adjacent to the parking at the entrance side.

Orientation of the research building is facing north and south, so that the building is exposed to minimum sun load in the summer, and so that one side recieves the benefit of north light.

Prevailing winds from southwest provide for good cross-ventilation; that is important, since this building will not be air conditioned.

The resulting position of the units with the openness of the recreational space in front, offers an interesting special relationship as viewed down from the superhighway.

**PLANT ENGINEERING**

Machine shop and Maintenance Shops:

They are both service units. Machinery is being built and repaired here for the production department under instructions of the research men. Central location with access to the trucking court is essential.
Power plant.
Out of economic considerations central location is necessary. A railroad siding must be provided for fuel supply.
The parking lot location influences greatly the location of the working areas. Basically it should be nearest to the street somewhat separated from all plant areas for reasons of control, but at the same time close to all working areas.
Parking needs:
1. Garages and parking for trucks.
2. Parking for visitors.
3. Parking for employees. Number of cars equals presently to $\frac{1}{3}$ of total staff.

EMPLOYEE FACILITIES

Locker rooms are located adjacent to the production building on the way from and to the parking lot. It serves both the factory as well as the research and administration personnel. The cafeteria is also centrally located near to the locker and washrooms where the workers can clean themselves before going to eat.
The atmosphere should be relaxing. A pleasant garden with an adjoining playfield creates a good environment.
The construction of the plant is expected to start by next year as soon as a big increase in the film production will multiply.

The moving of the whole company will take place in a step by step schedule. For some years to come the operation in separate locations will still be necessary.

First development:

The whole film production department with the necessary service units and the photocopy service will be moved to the new location. The estimated number of employees is 500.

<table>
<thead>
<tr>
<th>Building</th>
<th>Sq.Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film production department</td>
<td>50,000</td>
</tr>
<tr>
<td>Warehouse</td>
<td>25,000</td>
</tr>
<tr>
<td>2-stories, 360x112</td>
<td>79,000</td>
</tr>
<tr>
<td>Photocopy Service</td>
<td>10,500</td>
</tr>
<tr>
<td>Plant maintenance</td>
<td></td>
</tr>
<tr>
<td>Machine shop</td>
<td>3,500</td>
</tr>
<tr>
<td>Repair shop of trades</td>
<td>2,000</td>
</tr>
<tr>
<td>Power plant</td>
<td>2,500</td>
</tr>
<tr>
<td>Employee facilities</td>
<td></td>
</tr>
<tr>
<td>Cafeteria (250 seats)</td>
<td>4,000</td>
</tr>
<tr>
<td>Kitchen (500 meals per hour x 3.2)</td>
<td>1,600</td>
</tr>
<tr>
<td>Locker rooms (500)</td>
<td>2,600</td>
</tr>
<tr>
<td>Washrooms</td>
<td>1,400</td>
</tr>
<tr>
<td>Toilets, stairs, etc.</td>
<td></td>
</tr>
<tr>
<td>Parking lot for 150 cars</td>
<td>107,300</td>
</tr>
</tbody>
</table>
Second development, 1954-55

At this stage it is appropriate to move the whole company to the new location.

Administration, Research and Engineering development are the big additional departments. Two (2) such production departments will be incorporated in the plant.

Since a substantial increase in film production is expected the two production floors with the warehouse will be extended towards north by a length of 168 feet.

The employee and facilities have to be tripled to meet the needs of a staff of 1500 persons.

<table>
<thead>
<tr>
<th>Department</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film production department</td>
<td>107,000</td>
</tr>
<tr>
<td>Polarizer (if at all here)</td>
<td>17,000</td>
</tr>
<tr>
<td>Plastics and optics</td>
<td>5,400</td>
</tr>
<tr>
<td>Warehouse</td>
<td>78,000</td>
</tr>
<tr>
<td>2-stories x 308 x 360</td>
<td></td>
</tr>
<tr>
<td>214,000 sq. feet</td>
<td></td>
</tr>
<tr>
<td>Photocopy</td>
<td>14,000</td>
</tr>
<tr>
<td>Plant maintenance</td>
<td></td>
</tr>
<tr>
<td>Machine shop</td>
<td>8,000</td>
</tr>
<tr>
<td>Repair shops</td>
<td>4,000</td>
</tr>
<tr>
<td>Power plant</td>
<td>3,000</td>
</tr>
<tr>
<td>Stock rooms</td>
<td>10,000</td>
</tr>
<tr>
<td>Employee facilities</td>
<td></td>
</tr>
<tr>
<td>Cafeteria 750 seats</td>
<td>11,500</td>
</tr>
<tr>
<td>Kitchen 1500 means per hourx2.4</td>
<td>3,600</td>
</tr>
<tr>
<td>Stock rooms</td>
<td></td>
</tr>
<tr>
<td>Locker rooms</td>
<td>9,700</td>
</tr>
<tr>
<td>Washrooms</td>
<td>2,800</td>
</tr>
</tbody>
</table>

Construction of second development.

<table>
<thead>
<tr>
<th>Department</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>37,100</td>
</tr>
<tr>
<td>Research</td>
<td>24,000</td>
</tr>
<tr>
<td>Engineering develop.</td>
<td>34,000</td>
</tr>
<tr>
<td>Plant engineering</td>
<td>5,000</td>
</tr>
<tr>
<td>6 stories - 80 x 160</td>
<td></td>
</tr>
<tr>
<td>Parking lot for 600 cars</td>
<td></td>
</tr>
<tr>
<td>Gate house</td>
<td></td>
</tr>
</tbody>
</table>
Any future and possible maximum development.

The manufacturing plant with the warehouse can be extended towards north to a size of:

- 504 x 360 of two floors with a floor area of 366,000
- 220,000 sq.ft. for production
- 146,000 sq. ft. for warehouse.

From now on the expansion can be directed only vertically:
- each floor adds: 110,000 sq. ft. for production
- 73,000 sq. ft. for warehousing.

The maximum development is achieved by a 4-story structure with:
- 440,000 sq. ft. for production
- 292,000 sq. ft. for warehousing
- TOTAL: 732,000 sq. ft.

The employee facilities can be extended vertically and horizontally towards south to meet the requirements of the actual size of the staff. The plant maintenance facilities will be extended horizontally.

The Administration, Research, Engineering-Building can be extended towards west to a final length of 320 feet. That has a capacity of 154,000 sq.ft. in a six floor structure with an additional penthouse and a roof garden deck.
Planning of the Plant.

General objectives.

What characterizes most an industrial building of today is the continuous flow of materials and the possibility of gradual expansion, in order to meet changing conditions and especially the everchanging design of products.

The final aim of a plant layout is to obtain the finished product at a least possible cost. The layout should be the expression of a purpose, the sequence and flow of work and material, which is determined by the process. That will determine the location of machines, service departments, production departments, storage areas, the handling methods and finally also the optimum size of the plant.

The main objectives in a plant layout are:

1. Reduce handling to a minimum. Moving and handling of materials add only to the cost of the final product and absolutely nothing to its value.

   Primarily the task is to find "one best" route for moving materials from the receiving dock to the shipping platform by:

   a. shortest possible distance
   b. shortest possible time
   c. lowest cost.

2. Best layout achieves minimum cost for moving materials, but it should be consistent with the needs of supervision, the personnel and process.
3. Long term, lowest cost layout requires pre-planned flexibility for expansion or consolidation, for new products and methods.

Lowest cost today might be "high cost" in the future if these factors are neglected.

4. Employee convenience, comfort, health and safety during the work.

Planning and execution of plant layout is today an advanced science.*

The main two tools are:

1. The flow process chart
2. Layout diagram, with templetts and plans.

* Excellent books on this specific subject are:

James M. Apple "Plant layout and materials handling".

Randolph W. Mailick "Plant layout".
FILM PRODUCTION DEPARTMENT FLOW CHART AT PRESENT

1. POSITIVE FILM COATING
   - CHEMICALS MIXING FOR:
     - POSITIVE FILM COATING
     - MASKING PAPER COATING
     - DEVELOPER POD SOLUTION
   - PAPER ROLL SLITTING
   - STORAGE
     - FIRST COATING
       - STORAGE
         - SECOND COATING
           - SLITTING
             - STORAGE
               - QUALITY CONTROL

2. MASKING PAPER COATING
   - SLITTING
     - STORAGE

3. DEVELOPER POD SOLUTION
   - STORAGE

FILM COATING DEPARTMENT

POSITIVE FILM ASSEMBLY
- .25 FEET LONG MACHINES SYNCHRONIZED
- PERFORM A MULTIOPERATION
  - SANDWICHING
  - PUNCHING
  - CUTTING
- STORAGE

NEGATIVE FILM SPoolING
- STORAGE

FILM ASSEMBLY DEPARTMENT

POSITIVE AND NEGATIVE FILM SPlicing
- SEALING
- WRAPPING
- BAGGING
- PACKING IN BOXES
- PALLETING
- SHIPPING

PACKING DEPARTMENT
FILM PRODUCTION FLOW CHART IN FUTURE

FILM COATING DEPARTMENT

CHEMICALS MIXING FOR
1. POSITIVE FILM COATING
2. MASKING PAPER COATING
3. DEVELOPER POD SOLUTION

FIRST COATING
SECOND COATING
STORAGE
SLITTING
STORAGE

FIRST COATING
SECOND COATING
STORAGE
SLITTING
STORAGE

POSITIVE FILM ASSEMBLY
SANDWICHING
PUNCHING
CUTTING
ETC.
SYNCHRONIZED MULTIOPERATION

NEGATIVE FILM
CUTTING
STORAGE
NEGATIVE FILM
SPOOLING
STORAGE

STORAGE

PACKING DEPARTMENT

POSITIVE AND NEGATIVE FILM SPlicing
SEALING
WRAPPING
AUTOMATIC BOX MAKE UP MACHINE
OVER WRAP MACHINE
PACKING
PALLETING

SHIPPING

QUALITY CONTROL
Manufacturing activities in the Polaroid Corporation will be concentrated on production of:

1. "Land camera" photographic film
2. X-ray film for a quick development process
3. Photocopy service

The products are still in a pilot plant stage, although the photographic film has one year of production experience behind it. New methods and improvements are introduced constantly and it will take many more years till a standard production method can emerge. Therefore it is only possible to describe some general directives for the present time.

Because of the everchanging nature of the products a maximum adaptability and flexibility in floor space is the first commandment. There should be as few as possible obstructions. The machines now in use have dimensions up to 40 feet and 25 feet in length. In the future, when the products will be manufactured on a truly mass production basis the machines will become even bigger, longer in size and the process also more continuous.
X-ray department.

The production process for the X-ray films is still in the stage of engineering development.

Photocopy department.

The photocopy department is engaged in producing copies and enlargements of the photographs taken by the "Land camera". It is entirely autonomous, having no connection with other production departments. The essence of its operation is in speedy service. The orders arrive by mail in the morning, the pictures are processed immediately, and in the afternoon they are sent back already to the client by mail. Although the operation is running already smoothly, the methods are steadily being improved, therefore the floor area should be continuous for any possible rearrangement. No extremely large structural bays are necessary here. The department is located nearest to the street to be convenient for a quick and smooth deliveries.

Film production department.

The Polaroid Land Camera is a unique photographic apparatus. The positive picture is obtained in 60 seconds after the negative film has been exposed. This process takes place in the camera that acts here as a darkroom. A small amount of developer solution is pressed from a pod between the negative and positive films. By this contact process both films are developed and fixed and the positive picture is ready for use.
The film department produces the positive film, assembles the negative film with the positive film to a 8 picture roll. Finally it is packed airtight into boxes and is so ready for shipment.

The flow chart explains best the sequence of the work.

The positive film is produced in 40 foot long machines by coating Baryta paper with chemical solutions. The different types of papers are slit to proper film width and then introduced into a synchronized multioperation machine, where the positive film is sandwiched to a masking film, pods are added to all pictures, then cut into proper film length of 8 exposures and finally rolled up. It is all an automatic operation attended by two skilled workers per machine.

The assembly of the negative and positive films and the final boxing is done by hand by women workers.

Quality control.

All production is closely supervised by laboratory quality tests. Since the tests have to be done immediately this unit is located centrally in the service core. The type of space used for quality control is: darkrooms, laboratories, and offices.

Warehouse.

From the material handling point of view a one story layout is most preferred. It would allow an uninterrupted flow of materials and handling costs are also much cheaper in horizon-
tal operation.

But because of the already discussed site factors a multistory building would have to accommodate the operation here. To achieve still the benefits of an one-story plant, the production area is placed horizontally adjacent to its material storage and shipping areas. The different production departments are thisway stacked up vertically.

The solution here is:

First floor: Photographic film production, storage, shipping
Second floor: X-ray film production, storage, shipping

In a twostory warehouse materials can be elevated either by a system of conveyers, elevators, or even by fork lift trucks if it proves to be economical.

Service areas.

To eliminate obstructions on the production floor layout, all service areas are located in a central core. That includes:

Elevators, stairways - maximum distance to any exit is 150' 
Men's and women's toilets. A close location saves time.
Quality control laboratories.
Air conditioning equipment and ducts.
TECHNICAL CONSIDERATIONS.

Structure.
Since the products are highly inflammable, the manufacturing plant must be of fireproof construction. A concrete structure suits well; it is economical and the material is more available since it uses less steel. The baysize is 28 x 36 feet.

For expansion reasons the outside walls must be of high salvage value. All walls will be composed of standard panels, 9 x 14 feet in size. They are demountable and could be reinstalled in a new location with the help of a crane. The panels are composed of glass blocks held together by a frame of prestressed concrete. The glass blocks extend from floor to ceiling. For purpose of vision standard clear glass panels of the same size will be inserted at desired locations.

Airconditioning and dust control.

Film production demands an exact control of temperature, humidity and dust. The airconditioning units will be placed in strategic locations in the central service core.

Lighting and acoustics.

The whole plant will be lighted by new flourescent tubes with surface brightness of only 930 foot-lamberts. To cut down even more of the glare, the whole ceiling should be of suspended corrugated plastic carried by V-shaped acoustical sound absorbing fins.
The first three floors of the six story building will be occupied by the administration. Visitors have an immediate access this way. The ground floor contains only a spacious lobby and a display of the activities of the Corporation. From the lobby and the terrace it is a pleasant view into the garden in front of the cafeteria and to the playground in the distance.

The offices are designed on a unified module. Movable partitions allow for any desired form of office space. For psychological reasons it is desirable to keep the general clerical offices medium sized.

The top three floors and the penthouse will be used by the Research and Engineering development. These two departments work hand in hand.

Because of the great need for service areas a whole 18 feet wide service core is located along the center of the building. All toilets, darkrooms, storage areas, utility ducts, files etc. are positioned here with corridors on both sides. All rooms facing south and north are reserved for laboratories and offices.
Research Laboratories  
(Main St.)

Roof Buildings

- Crystallography laboratory with small adjoining instrument laboratory
- X-ray laboratory includes developing set-up
- Small electronics laboratory for special project
- Radiation storage room
- Infrared drying room for sheet material
- Cytology animal room
- Recreation room (ping-pong, etc.)

5th floor

- Research Library with 2 more book stacks in hall
- Small room to house the ultraviolet color translating microscope
- Central room for storage of chemicals and glassware
- Cytology laboratory
- Small chemistry laboratory - special project (1 man) - including desk
- Organic laboratory (5 people) - adjoining office for 4 of 5 chemists
- Large special laboratory for special chemistry project (3 people with doubled up desk room)
- Crystallographer's office and small laboratory combined
- Special organic chemistry laboratory (2 men) with desk
- Another special chemistry laboratory (2 men) with 1 desk
- Office of the Associate Director of Research
- Office for 3 secretaries and files (actually in a walled-off hall space)
- Office of the President
- Adjoining office of the secretary to the President
- Ladies' room (very inadequate facilities and poorly arranged)
- Men's room

4th floor

- Small electronics lab with 2 very small labs - one for photography, one a dust-free room for bolometer work
- Larger electronics lab and storage room combined with an attached 1-desk office
- 3 physics offices in a row for the top physicists and 1 secretary (4 men)
- Small dark room for color work
- Spectroscopy laboratory and desks (2 people)
- 3 more small offices for the top physicists and 1 secretary (includes total of 6 men)
- Small dark rooms for spectroscopy and photography
- Small drafting room for model design (2 tables, 1 desk)
- Large room containing testing equipment and drying ovens (used by all chemists and physicists as needed)
- Model shop with machines and equipments of all types, as well as some storage materials

3rd floor

- Plastics development laboratories (2 adjoining) - 3 people
- Small office for head of plastics dept.
- Room for special physics project (2 people)
EMPLOYEE CIRCULATION.

The employees enter the plant by foot through the gate house. For sake of better control non-private automobiles should enter the plant area.

The employees' entrance is situated at the south end of the employees facilities wing. By a staircase they reach their lockers and time clock on the second floor and third floor.

The lockerrooms and washrooms are centrally located to all work areas and also to the cafeteria. This convenient location will encourage the employees to clean themselves before their meals.
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