A REDEVELOPMENT OF THE WESTGATE AND WESTGATE WEST SITES, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE

Submitted in partial fulfillment of the requirements for the degree Master in Architecture, Massachusetts Institute of Technology.

John Anthony Curtis
25 May 1953

Lawrence B. Anderson
Professor of Architecture,
Head of the Department of Architecture.
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ABSTRACT OF WRITTEN REPORT

A REDEVELOPMENT OF THE WESTGATE
AND WESTGATE WEST SITES

JOHN ANTHONY CURTIS

Submitted in partial fulfillment of
the requirements for the degree
Master in Architecture, 25 May 1953,
at Massachusetts Institute of Technology

Though a large portion of the western end of the campus has been devoted to the temporary housing of married students since 1946, it is realized by the Institute that the solution is a temporary one. With the expectation that the number of married students attending MIT will not decrease to any great extent over the coming years, a sound solution which would fit into a complete redevelopment of that entire area of the campus was sought.

The temporary allotment of twenty-four acres of land to the above housing was a luxury based on expediency. Today, the Institute is facing the problem of placing the following facilities on West Campus:

Married Students Housing
Additional Dormitory Space for an Increasing Enrollment
Ten or Twelve Fraternities
Additional Playing Fields

Parking Facilities

The problem of the thesis was to examine the needs and determine the possibilities of developing a Master Plan which would locate all of the above facilities. In addition to this, an attempt was made to demonstrate more precisely how these elements might be developed. Though many of the major and minor points which were brought up during this study have not been examined in great detail, they have been noted and evaluated.

Finally, an economic study of the possibilities of actually financing such a redevelopment was made in order to prove that, in reality, the problem might be feasible. The assumptions are often based on questionable analyses of available information, but, being clearly set forth, they may be reexamined and adjusted to point the way to a final judgment of the basic concept which motivated the design.
25 May 1953
Cambridge, Massachusetts

Pietro Belluschi, Dean
School of Architecture and Planning
Massachusetts Institute of Technology
Cambridge, Massachusetts

Dear Dean Belluschi:

AND WESTGATE WEST SITES, is submitted herewith in partial fulfill-
ment of the requirements for the degree Master in Architecture.

Respectfully yours,

(John Anthony Curtis)
ACKNOWLEDGMENTS

To NAOMI, who broke all speed and accuracy records in typing this thesis.

To PIETRO BELUSCHI, Dean, School of Architecture and Planning, for suggesting the topic and giving me valuable advice and criticism along the way.

To E. F. BOWDITCH, Dean of Students and Mr. ROBERT M. KIMBALL, Director, Division of Business Administration, who spent many valuable hours helping me formulate my program and final solution.

For their constructive criticism and advice, I thank the officers and faculty members of Massachusetts Institute of Technology:

JEROME H. BARRAFORD, Assistant Superintendent of Buildings and Power
HERBERT L. BECKWITH, Professor of Architecture
WILLIAM H. BROWN, Associate Professor of Architecture
WILLIAM H. CARLISLE, JR., Manager of Student Personnel
SERGE CHEMAYEFF, Visiting Critic, Department of Architecture
HENRY K. DOW, Manager of the Dormitories
CARL F. FIDE, Assistant Provost
I. J. GEIGER, Director of Athletics
ROBERT E. HEMES, Assistant Registrar
WOLCOTT A. HOKANSON, Assistant Bursar
BURNHAM KELLY, Associate Professor of City Planning
ROBERT B. NEWMAN, Assistant Professor of Architecture
CARL M. F. PETERSON, Superintendent of Buildings and Power
JOSEPH J. SNYDER, Vice President and Treasurer
FREDERIC W. WATRIS, Assistant to the Treasurer

For information and advice on many problems involved in my study, I thank the following:

HAMILTON COOKE, Investment Dept., New England Mutual Life Insurance Company
Mr. DENNIS, George H. Fuller Construction Company
SIDNEY HESS, Former Chairman of Interfraternity Council
CHARLES N. MARCH, Manager, 100 Memorial Drive
Mr. PIERCE, Investment Dept., New England Mutual Life Insurance Company
FEDERAL HOUSING ADMINISTRATION, Boston, Mass.
JOHN HANCOCK INSURANCE COMPANY, Investment Department
I. INTRODUCTION

At the end of the last World War, MIT was suddenly flooded with a large number of returning veterans. Many of these veterans were married. For the first time in its history, a large percentage of MIT's students were supporting families, at the same time that they were finishing up their interrupted educations. Over the past seven years, the percentage of married students has been, almost consistently, 22% of the total enrollment. During the first few years, most of these married students were returning veterans, but, though the number of veterans has gradually decreased, the number of married students has remained fairly constant. This is largely due to three factors: there are more and more older married students who are employed, part time, as DIC personnel on various types of research projects; the graduate schools have expanded a great deal since the war; due to the returning married veteran's example, it is now a recognized fact that it is quite possible for a student to get married before he has completed his formal education, without undue hardship.

Like many other educational institutions, when MIT was faced with this great increase of married students it recognized the problem and took steps to give them inexpensive, temporary housing, in order to lighten the financial load of supporting a family, which the married students chose to bear. MIT benefited in that it was able to offer this inexpensive housing to married students, and, thereby, was able to attract many capable married students who might have been unable
to attend college at all, because of financial burdens. Others might have chosen another college on the basis of the fact that MIT offered no solution to the housing problem.

MIT's answer to the need for this type of housing was the construction of Westgate and Westgate West. The land was available. The need and the solution were considered temporary. Since it is apparent that the need will probably be a permanent one, MIT is now faced with the need for a permanent solution. At the same time, it will be apparent from my study of the problem, that the land which was devoted to married student's housing, when the emergency measures were taken, must now accommodate other growing problems faced by an expanding campus.

I have taken this problem - the redevelopment of the Westgate and Westgate West sites - as my thesis.
II. BASIS FOR THE DEVELOPMENT OF A MASTER PLAN

Though the present buildings have remained on the site longer than originally anticipated, and though it seems likely that they will continue to be used for another five to eight years, in any overall future planning of the campus, it must be assumed that they will all be removed, eventually. The sooner a master plan for this redevelopment can be developed, the more easily the gradual transformation can be thought out and put into effect.

Though the files of various offices in MIT contained a great deal of data concerning the gradual growth and development of the campus, there were many questions which had to be reasked, in the light of the changes that have taken place during the years since the questions were originally posed and answered. The opinions of people directly concerned with the development problem today had to be ascertained and compiled, as the basis on which a program might be developed.

In an effort to obtain a firm basis for the necessary program, I was able to discuss the questions with the following members of the MIT staff:

Dean E. F. Bowditch - Dean of Students
Mr. R. M. Kimball - Director, Division of Business Administration
Dean Pietro Belluschi - Dean of the School of Architecture and Planning
Mr. Joseph J. Snyder - Vice President and Treasurer
Mr. F. W. Watriss - Assistant to the Treasurer
Professor L. F. Hamilton - Professor of Analytical Chemistry, Executive Officer and Assistant Secretary of the Faculty
Mr. Wm. H. Carlisle - Manager of Student Personnel
Professor Herbert L. Beckwith - Professor of Architecture
Mr. Henry K. Dow - Manager of Dormitories

It was on the basis of these interviews that I attempted to make sound, realistic assumptions. Not only were the questions discussed, but once they had been compiled, the resulting assumptions were reviewed and approved by the particular members of the staff in the above list, most directly concerned with the particular problem. On this basis, it seems fair to assume that the basic assumptions I have made are in line with the present Institute policy as it now stands.

A. THE QUESTIONS AND THE RESULTING ASSUMPTIONS

The following is a summary of the questions asked and the answers which were obtained:

1. What is the present disposition of the MIT student body, i.e., where are they housed at the present time?

Disposition of students, Fall Term of 1952

<table>
<thead>
<tr>
<th></th>
<th>SINGLE</th>
<th>MARRIED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Campus</td>
<td>In Town*</td>
</tr>
<tr>
<td>Undergraduates</td>
<td>1500</td>
<td>655</td>
</tr>
<tr>
<td>Graduate Students</td>
<td>450</td>
<td>820</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>1950</td>
<td>1475</td>
</tr>
</tbody>
</table>

* The totals "In Town" were derived by subtracting the other known totals - On-Campus, In Frats and Westgates - from the total enrollment.

** Note: In addition to the above, there are a total of 80 female students, bringing the total enrollment to 5,075.
2. At what figure will the enrollment of the future probably be stabilized?

Undergrad - 3600; Grad Students - 2000.

3. What figures are available on the number of married students at MIT during the years since the war? How are these figures expected to change? How many units will be provided for housing these students?

<table>
<thead>
<tr>
<th>Fall Term</th>
<th>Total</th>
<th>Married</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1946</td>
<td>5172</td>
<td>1152</td>
<td>22%</td>
</tr>
<tr>
<td>1947</td>
<td>5662</td>
<td>1239</td>
<td>22%</td>
</tr>
<tr>
<td>1948</td>
<td>5433</td>
<td>1177</td>
<td>22%</td>
</tr>
<tr>
<td>1949</td>
<td>5458</td>
<td>1188</td>
<td>22%</td>
</tr>
<tr>
<td>1950</td>
<td>5171</td>
<td>881</td>
<td>17%</td>
</tr>
<tr>
<td>1951</td>
<td>4874</td>
<td>1002</td>
<td>21%</td>
</tr>
<tr>
<td>1952</td>
<td>5075</td>
<td>810</td>
<td>16%</td>
</tr>
</tbody>
</table>

It seems likely that the percentage of married students will remain fairly constant in the future, therefore, as the total enrollment approaches 5600, there will be 1100-1200 married students.

MIT is not anxious to tie up any large amount of money in this type of a real estate investment, but it recognizes the need. A safe assumption might be around 350 units. This would more than replace the present temporary buildings (270 units), as well as Bexley Hall which will be torn down as the new plaza is built. It is probable that even 700 units could be rented without any vacancies, if the designs and rents were attractive. However, 350 seems like a more realistic figure, as to what might actually be built. Obviously, aside from the financial problem, there is the problem of the shortage of land.
4. On the basis of reports made during the past few years, it would seem safe to assume that at least ten or twelve of the present twenty-six fraternities might be talked into moving into some sort of attractive accommodations on campus. Forgetting the problems of location and design, how probable is this move? How will this be financed? Are the fraternities expected to remain constant in size?

Since the problem has been carefully considered over the past few years, it is safe to assume that, at present, there are two major obstacles to overcome before instituting any such move. The first is the arrangement of some means for the fraternities in question to finance a new building. The money might be loaned by the Institute, though it seems unlikely that MIT would be interested in any such deal for another five to eight years. This is the length of time before which the money presently invested in new dorms, etc. will have been returned to the Endowment Fund. The second obstacle is the lack of any plan which would indicate the location of fraternities on campus, if they were to start making the move.

As for the size of the fraternities, it can be assumed that this will remain constant. The fraternities prefer to have a certain percentage of their members living out of the house. Economically, this is more feasible than providing accommodations for every member, with the resulting vacancies, off and on, as the membership fluctuates. At present, there are 960 fraternity men and the houses accommodate only 760. There are twelve fraternities with accommodations for thirty to forty members and thirteen which house between nineteen to thirty men. The mean is twenty-nine beds.
5. What is your opinion on the actual dates of the demolition of the Westgates?

They will probably be torn down over the next seven years.

6. How available are the Sunoco, Smith House and Howard Johnson sites?

Quite definitely available in any plans for the future. The present leases on the properties in question will expire within the next eight years.

7. What is your opinion as to the grouping of the various classes of students, i.e., freshmen, grads, etc.?

Most people agree that at least the grad students should be separately housed. It seems likely that they will eventually be moved to East Campus, leaving the dorms on West Campus solely for the undergraduates. At present, the Grad House accommodates 450 students. Since there is, consistently, a waiting list of approximately 125 students, and since the total number of Graduate students is expected to increase to 2000 (the present figure being 1920), it is likely that the East Campus dorms with 627 beds will be of about the correct size for a future Grad House. The move to East Campus would involve considerable remodelling but one factor which would appeal to the Grad students is the large number of single rooms on East Campus. This shift has not been decided.

There is no agreement on whether or not the undergraduates should be housed in any particular system of grouping. However, this should not affect plans for additional dorm facilities on the Westgate site.
8. What is the present capacity of the dormitories?

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<table>
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<tbody>
<tr>
<td>Baker House</td>
<td>349</td>
</tr>
<tr>
<td>Graduate House</td>
<td>450</td>
</tr>
<tr>
<td>Burton House</td>
<td>592</td>
</tr>
<tr>
<td>East Campus</td>
<td>627</td>
</tr>
<tr>
<td>Total</td>
<td>2018</td>
</tr>
</tbody>
</table>

9. How many additional dorm facilities will be necessary in the future?

If the Grad Students were moved into the East Campus dorms, this would leave a total of 1391 beds on West Campus for the Undergraduates.

Since the total undergraduate enrollment is expected to increase from 3075 to 3600 (or 14.5%) and since there are now 1500 undergraduates living in the dorms, by the same percentage, it seems safe to assume that a total of 1750 beds will be necessary in the future. This is an increase of 359 over the present capacity.

(It should be noted that, though there are 1568 undergraduate beds available at present, only about 1500 are occupied.)

Another important point here is the fact that it is considered probable that 550 undergraduates might be housed in The Grad House which now houses only 450 grad students. This would add another 100 beds, reducing the need for new facilities from 359 to 259. Therefore a figure somewhat below 359 might be considered a good estimate.

10. At the present time is any expansion over the present boundaries of the MIT campus contemplated, which would directly affect the redevelopment of the site I am concerned with?
No. It is planned to keep all living and recreation facilities within the boundaries of the present campus. Future research buildings, etc. may be located off of the present campus, but this should not effect the Westgate replanning problem.

11. What changes are contemplated in the present food services on campus?

This is a complex unsolved problem, but, in the event that an apartment house were built (rather than a regular dormitory), to take care of the increasing number of undergraduates, the future planning of the campus eating facilities would not be involved in the redevelopment plan.

12. What additional areas are necessary for expanding the athletic facilities?

The present athletic fields have been encroached upon twice within the past decade. The additions of Westgate and the new auditorium and plaza have trimmed down the fields at both ends.

In any future plan, the present tracks (2), soccer field (1), baseball field (1), tennis courts (2 sets), hammer field (1) and lacrosse fields (2) must be kept or relocated. In addition to these facilities, an additional baseball field, three to six tennis courts and several softball fields should be added.

13. How will the parking problem affect my site?

This is another unsolved problem, but it would seem safe to assume that the minimum parking facilities that should be included in the redevelopment should be ample to take care of any married or single students housed on the site, thereby not increasing the parking problem in adjacent areas.
14. Considering the expense of building apartments, in what way could MIT finance any future construction for the housing of married students?

   Government loans, gifts, special building funds are all possibilities, but the safest conservative working assumption would be that MIT might use money from the Endowment Fund, as it has been forced to do in the past. If this were the case, it is likely that the Institute would not be anxious to make such an investment for several more years, and it is probable that a minimum return of \( \frac{5}{4} \)\% over a period of forty years would be expected. It is unlikely that this expected return would be reduced if the sole source of funds was diverted Endowment Fund money.

15. In a new dormitory, would it seem desirable to provide the absolute minimum of furniture, on the assumption that the students would provide most of their own furnishings - thereby saving this extra cost?

   No. It seems to be a more satisfactory arrangement to provide all of the essential furnishings for dorm rooms, thereby eliminating the bother and expense of students having to deal with furniture "sharks" each year.

16. Could a dorm-apartment house ever be considered as a possible answer to the need for additional dormitory facilities?

   Yes. However, it must be proved practical desirable and economical. The idea itself is interesting and may have possibilities.

17. What future plans for housing female students should I consider?

   It is unlikely that the number of female students will change in the future. At present there are about 80. Some time in the future, it is probable that a dormitory will be provided to take care of twenty to forty girls. The purchase and conversion of the small hospital next to
Baker House has been considered. Another possibility is the dorm behind the President's House. In any event, it would not be unreasonable to feel that this problem will have no effect on the proposed redevelopment problem.

18. Considering the above information, what are the facilities which might reasonably be expected to be designed into a master plan for the specific site with which my thesis is concerned - the area now occupied by Westgate and Westgate West?

The above data would indicate that the following facilities should be provided for in a Master Plan of the Westgate and Westgate West sites:

- A dormitory for approximately 350 single students
- Apartments for 350 married students
- An area which could accommodate any future plans for the location of ten or twelve fraternities
- Adequate parking facilities
- An additional baseball field, several softball fields and three to six new tennis courts.
III. FORMULATING A PROGRAM OF REQUIREMENTS ON THE BASIS OF THE
ASSUMPTIONS MADE

Before discussing the solution and seeing how this program was
developed into a design, I would like to put forth the main objectives
I felt should be sought for, in the design of each of the separate
elements, as well as the overall site plan.

A. APARTMENTS FOR MARRIED STUDENTS

In a housing problem of this sort, the tenants are of a very special
type and, therefore, have needs which differ in emphasis when compared to
the usual requirements in low cost housing developments.

Their characteristics and needs are as follows:

- The average age of the couples is close to twenty-five. There will
  be few older couples in their thirties.

- Though most of the couples will have been married a comparatively
  short time, it is probable that there will be a high percentage of
  children. As the students whose education was interrupted by the war
decrease, there will tend to be even a lower average age - and years of
  marriage - than has been true during the past eight years, and therefore,
  there will be somewhat fewer children. ¹

On the basis of this fact, it seems desirable to plan on 75% two bed-
room units, 2% three bedroom units and about 23% one bedroom units, with

¹ There are no figures available as to the number of children in the West-
gates at the present time, but most of the families in the two bedroom units
have at least one child. Few of the couples living in the one bedroom units
have children, and in most cases, these children are young babies. About 83%
of the present units are two bedroom units. Approximately 20% of the families
have two children and a very small number of families have more than two.
It must be remembered that couples with children are given preference on
moving into the project and it is likely that this practice would be con-
tinued.
a large enough bedroom to accommodate a baby, if necessary.
- The fathers are all busy with their studies.
- There is not much entertaining, except on a very small scale.
- About 75% of the students will have cars.
- The housing is a temporary arrangement and will be lived in for not more than a few years.
- There must be ample closet space but the storage space required by the young couples will not be as great as it would be in a regular apartment house where many of the couples have been married for ten years or more and have accumulated many more possessions.
- The maintenance should be simple and inexpensive.
- There should be some sort of central laundry facilities with automatic washers.
- There should be a store that can be supported by several hundred families which should be able to supply the basic needs for food, magazines, cigarettes, etc., as well as some kind of cleaning and laundry service.
- Above all, though the apartments should be of a comfortable size, providing pleasant surroundings for studying and children's play, the rent must be as low as possible.

B. A BASIC QUESTION WHICH WAS CAREFULLY CONSIDERED WAS:

1. High Rise vs. Low Rise

Advantages of high rise apartments:
- Use less land, more open areas and more area for other facilities which must be included on the site.
- Balconies would be sufficient for much of the outdoor activity of the very young children and would serve for a fair amount of the play for somewhat older children (giving easy supervision) - if adequate open areas are also provided around the building.
- The elevators simplify the problem of carrying packages and moving baby carriages (which might be kept in the apartments or on the balconies a great deal of the time).
- The nuisance of climbing several flights of stairs is eliminated.
- Each family would have complete privacy on their balcony.
- There is less maintenance of grounds.
- Students would have little time to develop an interest in maintaining their own piece of ground.
- There would be more contact among students in an apartment house than in a building with separate entries for each apartment.
- There would be more privacy and less noise than in units closer to the ground and walks.
- According to information available on the soil condition, it is unlikely that the foundation costs for one or two high buildings would be any greater than that for a large number of low buildings.

**Advantages of Low units:**

- A more personal closer contact with the outdoor play area, even if the units were three stories high.
- No problem of elevators for small children. Easier coming and going for their play activities.
- The low units could also be provided with balconies, affording the same advantages as for the High.
- Closer supervision from windows possible for mothers.
- More individual interest in maintaining the outdoor areas.
- More intimate outdoor spaces, a more human scale, in contrast with the somewhat inhuman scale of the campus areas at the present time.
- Eliminates most of the public indoor areas that must be maintained.
- Smaller gross area per apartment because of lack of interior circulation, but with comparable net rentable area per apartment.
- Greater number of units on the ground floor - with advantages of circulation, but disadvantages of lack of isolation and privacy.

In making a decision on what height my apartment buildings should be, I considered all of the above factors. I spoke to a large number of the present occupants of the Westgates and once they realized that MIT could not afford to build several hundred single story units, I found the opinions were quite evenly split.

The explanation of my final solution will show how I decided on a combination of the two, with 38% of the two bedroom, and all of the three bedroom units being located in low units.

C. DORMITORY-APARTMENT

The basic difficulty which I questioned when I first considered the problem of a new dormitory design was - with all of the difficulties colleges seem to have in the building of new dormitories that pay for themselves, what major change could be introduced which would make it possible to design pleasant living areas which would be comfortably spacious and which would attract the students to live on the campus yet be inexpensive to
maintain, inexpensive to build and inexpensive to occupy. The only source of money that can be counted on will have to give a return of 4% over a period of forty years. The needs seemed incompatible. The necessary results did not seem to jibe with the expensive experience of most colleges faced with this same problem. This was the reason for my major decision in formulating the program for a dormitory for single students. I decided on an apartment house with regular apartments, adapted to the needs of single students in school.

Without going into the details of cost, maintenance and financing at this time, the following five examples will give some indication of how the costs of my proposed building compare with several other projects. Though each figure has qualifications such as the year the building was built, the extra services, the furniture, etc., it will give some indication of why I favored an apartment house, if on the economic basis alone.

**COMPARISON OF FIVE DORMITORY COST FIGURES - COST PER STUDENT**

<table>
<thead>
<tr>
<th>Source</th>
<th>Description</th>
<th>Rent per Term</th>
<th>Gross Return on Cost of Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIA Bulletin May 1949 - &quot;Trends in Men's Residence Hall&quot; (Report on Twenty Eastern Colleges)</td>
<td>not including furniture</td>
<td>$3240</td>
<td>not given</td>
</tr>
<tr>
<td></td>
<td>rent per term</td>
<td>$33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>gross return on cost of project</td>
<td>not given</td>
<td></td>
</tr>
<tr>
<td>Harvard Graduate Center - 1949</td>
<td>not including furniture fees, commons and dining building</td>
<td>$3250</td>
<td></td>
</tr>
<tr>
<td></td>
<td>not including furniture but including other of above</td>
<td>$4360</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rent per term</td>
<td>$148</td>
<td></td>
</tr>
<tr>
<td></td>
<td>gross return on cost of project</td>
<td>not given</td>
<td></td>
</tr>
</tbody>
</table>
Baker House - 1949

- not including furniture but with dining and social facilities: $6570
- including furniture and above: $7326
- rent per term: $190
- gross return on cost of project: 5.32%

Proposed Apartment - Dormitory - 1953 - Estimate, considering this building separate of other buildings to be included in thesis redevelopment

- not including furniture but all necessary service facilities and completely equipped apartment, 4 men per apartment: $3380
- including furniture and all above: $3736
- possible term rental: $160
- gross return on cost of project (including an 11% return on furniture): 8.30%

Obviously, there is some big reason for the difference in the cost of my proposal compared to the others, but without a thorough investigation into each individual case, the most obvious reason seems to be that it is cheaper to provide a complete apartment, furnished, including a lounge, laundry, snack bar and the other services usually provided in a regular apartment house, than it is to provide a series of small single and double rooms which are also furnished, and are provided with central dining facilities, lounges, public toilets and large public circulation areas.

Considering this assumption to be correct, following some very preliminary sketches and calculations, I considered the other pros and cons for
this type of a building. The most important factors were brought out in discussions with Dean Bowditch, Dean of Students and Mr. Kimball, Business Administrator. These were:

- It would cost students less to live in a completely equipped apartment, because even if the rent were the same or more than a dormitory room, the students could - if interested - cook most of their own meals. This can be done for $35 - $45 a month per man. The quality and quantity of the food could be far above that which MIT can provide in their expensive-to-operate contract feeding plans - depending upon the enthusiasm and talents of the students. When compared to the cost of eating in town, the savings are even more dramatic.

- It would attract students who dislike a regular dormitory and might be tempted to move into a town apartment, thus keeping them on the campus. The advantages over a town apartment would be - no transportation cost, convenience, a building designed to suit the particular needs of students and yet accommodations more homelike and suitable to maturing students than the more prep school-like dormitories. Also, the students would all be together which would tend to make their fellow students and the campus life more a part of their life - avoiding the commuters' isolation.

- The apartments would be completely furnished as the cost of furniture is small compared to the advantage to the student and the slight increase in rent. This would put these apartments at another advantage over town apartments. There would be no necessary heavy investment in furniture, and even if the town apartment were furnished, undoubtedly the furniture would not be exactly suited to a student's needs.

- If students did not want to cook all of their own food - which many of them already do in town or on illegal hot plates in the dorms, they would
still have eating places such as the Grad House nearby.
- Parking would be provided - at least one space per apartment - but shopping would be simplified by having a well-equipped store in the married students' apartment building.
- Classes, playing fields, labs, and extra curricular activities would be conveniently near by,
- Students would have to do their own cleaning - though a porter service might be considered and complete bedding; a clean linen service could be provided at the present rate of $12.50 per year. (This is included in the dorm rents, at present.)
- The students would have attractive places in which to entertain their friends (with or without "House Rules") and develop habits of social intercourse and poise in more normal surroundings.
- Four students could be accommodated in each two bedroom apartment, not only making it more feasible, economically, than three or two, but also forming a more socially suitable grouping than that achieved by having three or two man apartments. Four man suites are a common thing at many colleges and seem quite popular. It would also seem desirable to have enough flexibility in the plans so that each apartment could have either two double rooms, with two desks in each or one study room with four desks and one sleeping room with four beds. The storage and closet space would have to be ample to adapt to either of these arrangements.

Survey

The above are some of the main pros and cons which were thoroughly discussed with Dean Bowditch, with the conclusion that the proposal might be a very reasonable and workable idea. A survey of fifty students was made to
ascertain what the students' reaction would be. Half of the students talked to lived in Baker House (where the rents are $190 per term and the contract feeding plus week-end costs a minimum of $65 a month), and the other half were occupants of East Campus and Burton House (where the rents are closer to the overall campus average of $163 per term.

In order to obtain opinions of definite value, the advantages were pointed out, but the disadvantages of such a scheme were strongly emphasized and discussed. As a result of these comprehensive interviews, it was found that almost ninety-five per cent of the students were enthusiastic about the idea and said they would make a real effort to move into such a building. A small percentage were indifferent and then there were a few who would much prefer the labor-saving dormitory life, even if the rents were less. Considering the fact that fifty students were interviewed at random, and considering a building of this sort would only house about 350 students (or less than ten per cent of the total enrollment), it would be safe to assume that the building would have no vacancies, particularly if the "leases" were for a full 8.65 month school year.

The opinion was expressed by several students that this type of accommodations would probably not be appealing until their Sophomore or Junior year.

When questioned as to the rent that they would be quite willing to pay, it was emphasized that, though a considerable saving in food costs could be realized, it was important to remember that the combined rents of four students for a single apartment might amount to quite a high total rent. Therefore, they were asked to state a rent that was not only considered very fair, but a rent that would be tempting enough to arouse enthusiasm, with no doubt, when deciding whether or not they wanted to move into this type of accommodations.
The results of this rental question were as follows:

- Of the students now living in Baker House, the average proposed rent was just under $240 per term. Only one student felt that the rent should be the same as Baker House - $190 - and only three more proposed rents under $215 per term. Ten students suggested rents over $250 per term with several of them quite willing to pay more.

- In the second group who lived in the less expensive rooms on campus, the average proposed rent was $223, with the lowest figure (one student) $190 and only four students proposing rents under $215.

As will be shown in the final economic analysis of this project, the students' enthusiasm and willingness to pay was sharply tempered by a conservative proposal as to what the desirable rent should be.

D. OTHER OBJECTIVES LISTED IN THE OVERALL PROGRAM

The other elements considered in the program were:

- The inclusion of a large area for development as a Fraternity Area
- The necessary playing fields, as listed earlier, and secondary outdoor areas.
- Parking as required
- An integration of the new site plan into the present existing site plan forming the link between the Westgate sites and Mass. Avenue.
- An effort to provide a series of building which would be economical to build, and easy and inexpensive to maintain.
sketch plan - showing redevelopment of westgate and westgate west
IV. THE DESIGN SOLUTION

A. GENERAL OUTLINE OF PRINCIPLES BEHIND THE DESIGN

The first question that was faced before any of the elements had been designed was whether or not all of the requirements of the program could be fulfilled. This required some very rough investigation of the site and the areas required.

1. THE SITE

The site used for the project is defined by Memorial Drive, to the south (including the Smith House, Howard Johnson and Sunoco sites), and Audrey Street to the west (which is the street running between the Westgate site and the MIT Wind Tunnel). To the north, the site is defined by Vassar Street, and to the east, the location of the outfield of the present baseball field and the tennis courts across Amherst Alley from Burton House define the boundary which is already marked off by the fence running the length of the Westgate West housing area.

The soil conditions are unknown but it is the opinion of the Grounds and Building office of the Institute that there is a steady improvement in the bearing quality of the soil as one moves west from Mass. Ave. It is their opinion that the proposed site would not offer any particularly costly problems.

Most of the site is zoned as "Industrial" which imposes a limitation of 100 feet on the height of any building, not including any sort of penthouse which can cover up to 30% of the total roof area. The line that defines the end of this zone cuts across the site, perpendicular to Memorial Drive, at a point approximately 130 feet west of the Number Six Club, the small building located at the western end of Burton House. The zoning
line does not go all the way to Vassar Street as it runs north, but makes a ninety-degree turn to the east at a point approximately 100 feet from Vassar Street. It continues in this direction across the present racing track, thus running south of Rockwell Cage, meaning that there is a widening strip along Vassar Street which is also zoned as an "Industrial" area. Then, the rest of the land on West Campus is classified as "Residential" with a height limitation of 65 feet.

The strange path of this zoning line would indicate that it is something that was formulated many years before the MIT campus started to spread across Mass. Avenue. Today, it seems quite arbitrary in its location. Though no one can guess what the result might be, it is the opinion of Mr. Kimball that it would be safe to assume that an exception in the 65 foot height limitation could be obtained. Though MIT prefers to avoid asking for unreasonable exceptions along this line, an exception in this case seems quite realistic and reasonable. This was a concern at the early stage of investigation, because the north-south border of this zoned area happens to cut off a 150 foot wide strip of the Westgate West site which falls within the "Residential" zone. As it turned out in the final design, a strict adherence to this zoning would have forced one of the tall buildings to move west approximately 100 feet which would have resulted in crowding the site at the western end while wasting area at the eastern end.

The other limitation on the site is a 10 foot sewer easement which runs diagonally across the site, at a point about 500 feet east of Audrey Street.
2. THE BUILDINGS

A rough blocking out of the expected areas of the buildings to be included, indicated that the twenty-four acres would just about be enough. If all of the married students and single students were placed in high buildings, some land would be saved, but these tall buildings would still require a certain amount of land surrounding them, so the saving would be slight over the final decision to put some of the married students in low units, three stories in height. (Another point brought out in the final design and further economic studies seemed to indicate that, due to the more expensive per unit cost of the units in the high building, largely due to the greater gross square footage required, the project would increase in total cost by about $500,000 if all of the married students' units were included in the high building. The final compromise seemed to be a reasonable balance between economy and total land coverage.)

This preliminary total area and construction cost study seemed to indicate a reasonable final outcome of the design, with the total square footage being within 15,000 square feet of the final solution and the cost figures being less than ten per cent off from the final calculations.

**Two basic assumptions made concerning the design**

There were two basic ideas which developed early in the design stage, and before I attempt to show how they tied in with the individual units, I shall outline them. These ideas were - the use of a lift slab method of construction and the use of some sort of a skip floor scheme.

a. Lift Slab

Since the economic feasibility of the final scheme seemed to be especially important, I was anxious to find some way to make some dramatic savings in the cost of construction. The proper choice of materials can
save a great deal of money, but I felt the problem required an even greater way of trimming costs.

From the past uses of lift slab construction, it appears to be a particularly exciting and yet obvious way of cutting down the cost of a building - if the building is designed with this in mind from the beginning.

There have been several excellent articles describing the principles of lift slab design, discussing the column design, the collar design, the slab design and the exact method of erection. I will only touch on the main considerations to be considered in the laying out of a plan so that the lift slab method may be used most economically, and shall quote a few very convincing statements as to the economies derived from this type of structure.

The columns most commonly used have been pipe columns, two steel angles welded into a box column or regular "H" columns. The most economical spacing is between 20 and 24 feet, the maximum practical span being around 30 feet for a conventional slab and 40 feet for a prestressed slab. The slab thickness is limited by the $L_{36}$ ratio and the bays should be as close to square as possible, with the practical limitation being a ratio of 1:1.33. It has been found highly desirable to provide cantilevers because of the corresponding reduction in positive moment in the interior spans and the uniform distribution of shear resulting at the column area. However, a vast amount of construction has been completed where the columns were located on the periphery of the slab. The piercing of the slabs, one
floor above the other is a simple matter though it is easiest to locate any large openings, such as stairwells, in the middle section of the bay. In the Trinity College Dormitory, completed in San Antonio in 1950, none of the expected obstacles were encountered when big openings for stairwells were located within a foot or two of the column lines.

All the slabs are poured on the ground and almost no formwork is necessary. Workmen can place the steel easily and quickly and without any danger from height. They can pour the concrete without first hoisting it up in the air - they pour one slab, then put sheets of paper on it, then place more steel and pour the next slab. Then after the slabs cure ten days a three-man crew puts hydraulic jacks on the top of each column and hoists them. No extra reinforcing is required in the slabs because the pressure of hoisting comes where the column supports will be anyway. They are supported at the columns by blocks welded under the collars cast into the slab for the hoisting machinery to grab.

The overall savings based upon actual jobs designed for the use of the method and so constructed have varied from 8% to 33% of the total cost of the job...

...all of the structural work on the slabs is done at ground level resulting in more efficient labor and an absolute minimum of equipment. Generally, all the concrete can be placed directly out of a transit mix truck or a mixing machine. There will not be any collapsing forms due to overload or a dropped concrete bucket. It is not necessary to use draglines or elevators to pour lift slabs. Actual costs for pouring lift slabs have been reported as from 42¢ to 54¢ per cubic yard not including finishing which has cost from 4¢ to 5¢ per square foot.

Another substantial saving is in the placement of reinforcing steel. The material does not have to be elevated to the forms up in the air and is therefore not handled as many times. These costs have run from $11.00 to $16.00 per ton of steel in place.

The greatest savings on large projects are in the mechanical and electrical portions of the work. All electrical conduits are placed in the slab before the concrete is poured. When the slab is raised the horizontal conduit is in place and the necessary risers and feeders between slabs can be cut and ready to connect. The same applies to a large portion of the mechanical roughing-in.

There are many savings in the use of the method, savings which have often been referred to as "hidden savings" but which are no longer hidden to contractors who have built by this method.

Time is, of course, money to all owners and the Youtz-Slick Method is most definitely a time-saver.

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1 "A New Structural Method" - Trinity College, Architectural Forum, June 1959
2 "The Youtz-Slick Lift Slab Method of Construction", published by The Institute of Inventive Research, P. O. Box 2296, San Antonio 6, Texas.
To quote from the article on the Corpus Christi Housing Project:

The Engineers used lightweight concrete, found its slightly higher cost offset by the combination of less steel with easier setting (second story steel averaged 2.7 lb. per sq. ft. of slab, was placed for about $13 per ton as against a usual cost of $40 to $50 per ton) and the easier pouring of concrete (it runs at less slump). Though specified at 3,000 lb. strength, concrete actually tested as high as 4,750 lb. after 28 days - due to lower water content.

Placing of concrete cost only about 50 cents per yd. compared with the local average of $3 for placing regular concrete on the second floor.

These quotations indicate the possibility of economical erection of the present buildings, once it is shown how they have been adapted to the above principles of the design method.

The only unusual feature in the present design is the factor of height. No buildings have been built over four stories, up to the present time. However, the explanation in Appendix A, taken from the article by Fred E. Koebel, "Progressive Architecture", February 1953, will give a clear idea of how this might be done.

Up to this time, there have been no examples of the lift slab method built in New England. The New England Lift Slab Company has been established in Boston for only about two months.

I was able to discuss, at some length, my particular design with the head of this firm (which is directly connected with Youtz-Slick of Texas), and I was assured that, though no multi-story buildings have been tried,

1 Architectural Forum, September 1950, p. 186.
and though the contractors in this area are unfamiliar with the method, it would be safe to assume that my design would present no significant obstacles. It would also be fair to guess that, were the buildings built after a few experiments in this area, the savings would amount to at least 10% to 15% over the conventional method of construction. The first slab in this area will be lifted for a school in Rhode Island during this coming summer, so it seems likely the method will be a familiar one to New England Contractors before long.

b. Skip Floor

Though the first skip floor apartment buildings were built in 1933, one by Pingusson in France and the other by Tullgren in Milwaukee, there seem to have been few of them built since. Only seven have been noted in the article on them in "The Architectural Record".

Some of the reasons it has not been tried more often are: code limitations might have complicated the planning; the types and sizes of the apartments required, no doubt, make it difficult to handle; the lining up of utilities and the general complications of the three dimensional jigsaw puzzle do not always fall into place without difficulty.

I considered it as a possibility from the start mainly for the following reasons:

- On my particular site, the southern view is superb and the view to the north is as bad as most views over an industrial area can be. It even includes railroad tracks within a few hundred feet.
- The good view is to the south.
- It would allow cross ventilation in most of the apartments.

1 "Building Type Serves a Five-Fold Purpose", by Julian Whittlesey, Architectural Record, February 1949.
The design of Eastgate was an outstanding example - close to home - showing that the method can lead to a high percentage of net rentable area to gross area, thereby leading to the obvious economy in the overall plan.

(Note: The comparison of net rentable area to gross area is one of several methods of testing the efficiency of a design. Since this method was used to compare Eastgate to the cross plan apartments at Fresh Meadows in Long Island, designed by Voorhees, Walker, Foley and Smith, I have used the same terminology so that I might make a similar comparison below. A further explanation will be included at that time.)

- The maintenance of public areas is reduced, thereby reducing the upkeep cost of the building.

- The area usually consumed by the extra corridors is included in the apartments themselves, and though it does not always contribute greatly to the net rentable area, it adds to the cubage and spaciousness of the units - if properly planned.

- It cuts down on the number of elevators necessary because the elevators have fewer floors to stop at and therefore can make a round trip in a shorter time.

- Finally, I discovered by working with the principle that, though it has limitations and may require a mixture of large luxury apartments and small efficiency units, it can be adapted to a scheme which contains apartments of all the same size (as in my dorm-apartment design) and may work equally well in a building which contains some small and some larger units (such as the one and two bedroom units in the married students' building). For an economical use of space, there are certain principles which seem to emerge, but within these limitations of general types of plans, a great many
variations are possible. (The economy required and the relationship between the sizes of the units to be combined strongly influence the overall type of skip floor arrangements.) Principles of circulation patterns emerge through the complicated process of trial and error.

B. THE SPECIFIC BUILDINGS

1. THE DESIGN OF THE MARRIED STUDENTS' HIGH UNITS
   a) Number and size of units
   b) How the lift slab fits into plan
   c) How the skip floor fits in
   d) Orientation
   e) The unit plans - areas
   f) Efficiency calculations
   g) Public circulation
   h) Public services
   i) Height limitations
   a. Number of Units. This high building contains a total of 159 two bedroom units and 78 one bedroom units. (This is 64% of the 249 two bedroom units and 100% of the one bedroom units that are provided for married students.)
   b. Lift slab. The column lines are located - one, just inside the exterior wall line on the side of the building where all the balconies are cantilevered out six feet, and the other, set back from the other exterior wall five and a half feet. The bay size is 21' - 4" x 27' - 0". This
bay size fulfills the basic requirements of lift slab design and the cantilevers help reduce the positive moment, as well as making it possible to span the width of the building with only two column lines.

Due to this economical system, one line of the steel fireproofed columns appear on one of the corridor floor unit plans and both of the non-corridor plans, five and one half feet in from the exterior wall. Though this would not be objectionable in the bedrooms it would seem wise to offset the party wall or furr in the recessed sections of wall where it appears in the living room. This happens in the corridor floor unit in only one out of every five units.

The stairs and elevators and other small areas outside of the main block of apartments must be poured separately, with conventional formwork. This was one reason that these elements were kept out of the main block. It was also found that for maximum simplicity in bay designs and minimum use of public circulation areas, it was best to have these elements run down the side of the block and avoid having them run through the regular bays.

c. Skip Floor

The double loaded corridor was worked out to have one one bedroom unit on either side of the central corridor, with the stairs leading (to the through-the-building units) above and below, running parallel to the corridor. In this way, the combination of the one and two bedroom units seemed to be well adapted to the double loaded scheme.
d. Orientation

Over 83% of the living rooms face in the same direction which simplified the problem of giving the best orientation to the majority of the units.

e. Unit Plans

The overall mass of apartment units can be split into sections three floors high (with the corridor floor in the middle and sandwiched by the non-corridor floors). The building was divided into 3-floor slices so that it could be compared with Fresh Meadows and Eastgate in section "f".

f. Efficiency calculations

The method for calculating the efficiency of the plan has been the comparison of the net rentable area (i.e., the area of the living room, the kitchen and the bedrooms, not including closets or any circulation areas), to the total gross area of the building. Adopting the method used for Fresh Meadows and Eastgate, a unit of three floors has been compared.

In the proposed building the areas are:

Two bedroom apartments, average net rentable area -

<table>
<thead>
<tr>
<th>Area</th>
<th>Square Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>living room</td>
<td>200 sq. ft.</td>
</tr>
<tr>
<td>bedroom</td>
<td>133 &quot;</td>
</tr>
<tr>
<td>Bedroom</td>
<td>115 &quot;</td>
</tr>
<tr>
<td>kitchen</td>
<td>60 &quot;</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>508 sq. ft.</strong></td>
</tr>
</tbody>
</table>

One bedroom apartments, average net rentable area -

<table>
<thead>
<tr>
<th>Area</th>
<th>Square Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>living room</td>
<td>157 sq. ft.</td>
</tr>
<tr>
<td>bedroom</td>
<td>133 &quot;</td>
</tr>
<tr>
<td>kitchenette</td>
<td>38 &quot;</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td><strong>328 sq. ft.</strong></td>
</tr>
</tbody>
</table>

A three floor slice of the building includes forty two-bedroom units
and twenty one-bedroom units - a total of 26,880 square feet of net rentable area. The total gross area of the three floor slice is 47,070.

A comparison of net to gross areas gives the following ratios:

- Fresh Meadows efficiency equals 51.1%
- Eastgate efficiency equals 55.1%
- New Married Students' High Unit equals 57.2%

This shows that Fresh Meadows (even with the central circulation core in an "I" shaped plan) has the lowest efficiency of net to gross areas. Eastgate is only slightly below the efficiency achieved in the New Married Students' High Unit.

g. Public Circulation

This has been kept to a minimum by running the vertical circulation up the ends of the two blocks of apartments that make up this building, and by making the elevator lobbies part of the galleries, which connect these two blocks since the space above and below the elevator lobbies on non-corridor floors would just be wasted space.

The length of the large blocks are the maximum allowable distance for the location of fire stairs. The secondary exit required for all apartments of four rooms or over - a Cambridge code requirement - is provided by the joining balconies, in the same way it was handled at Eastgate.

h. Public services

The laundry is located on the roof and the delivery entrance, the store, the office and other necessary service areas are located in the core which forms the junction between the two large masses.

i. The height limitations

Since land was at a premium, since the zoning limited the height of the
building to 100 feet, and since the floor to floor dimension was 8'-9", the total height of the building was 105 feet or 5 feet above the allowable limit. As the site is virtually level, it was necessary to sink the first floor level 5 feet below the elevation of Vassar Street. This places the lobby or second floor just 3'-9" above grade. The grading around the building was accomplished with low walls and gradual slopes as shown in the large site plan.

2. THREE STORY MARRIED STUDENTS' LOW UNITS

a. Number of units

b. General principle of plan

c. Areas

a. Number of units. A total of 90 two bedroom apartments and 6 three bedroom apartments are located in the three story units. This gives a grand total of 333 apartments for married students (a figure which could be increased by the erection of more low units - though this would cut down the fraternity area.)

b. Principles of plan. Any two-floor plans and duplex arrangements were rejected because of the shortage of land and because the gross area was consistently higher than the final scheme where the units are stacked three high with the circulation attached as open balconies at the back.

This type of plan concentrates all exterior walks along the back of the building, and therefore saves the entire front for the living areas all of which can face the most desirable orientation and all of which have the maximum of privacy.

The use of lift slab also influenced the location of the stairs outside of the regular column bays.
c. Areas. The total floor area of the two bedroom units is 619 square feet and the net rentable area is 469 square feet. (This does not include the balconies or exterior stairs). The three bedroom units have a total of 803 square feet with a net rentable area of 606 square feet.

3. DORMITORY-APARTMENT BUILDING
   a. Number of units
   b. How the lift slab fits into plan
   c. How the skip floor fits in - and orientation
   d. The unit plans - flexibility
   e. Furniture
   f. Efficiency calculations
   g. Public circulation and services
   h. Height limitations
   i. Number and size of units

a. Number of units. There is a total of 80 two bedroom units for four students each, and a series of seven, one bedroom units for two students each which are located under and above the elevator lobbies on the non-corridor floors. This total of 87 units houses 334 students.

   b. Lift slab. The column lines are located - one along the line of the front exterior wall of the building which has a solid bank of six foot cantilevered balconies - and the other, along the interior wall of the corridor, which runs down the back of the

   A. corridor floor plan
   B. below + above corridor fl. plan
single loaded corridor block of apartments. Thus, the corridor is cantilevered out five feet and, since the column line cuts across the bedrooms in the through apartments above and below the corridor, the outer half of the bedrooms are also cantilevered. This results in a bay size of 22'-0" x 25'-6".

As in the Married High Building, the vertical circulation area slabs are poured separately and the ground floor snack bar area slabs would be lifted separately, too. Again, the length of the block was determined by the necessary fire stairs which were kept outside of the regular apartment bays.

c. Skip Floor and Orientation. It was felt one of the large masses on the site should be parallel to the River and the view. Since the Dormitory-Apartment contained units of all the same size, it seemed particularly adaptable to the single loaded corridor. Here, the corridor plus an apartment parallel to it took up the same area as the two apartments located on the floors above - and below. The single loaded corridor made it possible to face all of the living rooms to the south, thereby turning away from Vassar Street completely.

d. Unit Plans. The plans provide ample storage space for clothes as well as larger items like trunks. The furniture, which will be described in the following section, is specially planned for the needs of the students and the possibilities of a flexible arrangement. Both bedrooms are regular doubles with two beds, two desks and drawer-and-shelf units which are located in the closets. These "bureaus" can easily be moved out of the closets to form regular bureaus three feet high. The purpose of this is flexibility in the sleeping arrangements. If the students should wish to have a single room for sleeping and use the other
bedroom exclusively for studying, the beds can become double deckers in one of the rooms, and all four desks can be moved into the other room. This still leaves the closets - one in each room. However, the "built in bureaus" can be taken out of both closets and all located in the space in the bedroom left by the two desks, which have now been moved into the study room. This leaves a full length closet in the bedroom, free of bureaus and with sufficient hanging space for four. It also leaves an empty closet in the study room - a welcome addition.

e. Furniture. A detailed description of the furniture for the Dorm-Apartment Units is included as Appendix B.

The total cost of furniture for each four man apartment is $1,400.

The total cost of furniture for each two man apartment is $915.

Total cost of all furniture for apartments is $119,000.

The furniture has not been designed in detail, but in general, the horizontal surfaces are of 1/8" plywood with wood veneer Formica finish. This can be bought for $.45 per square foot if bought in quantity. As a dining table (with out the use of a dining cloth) it is estimated to last about ten years. The surface can then be replaced by sanding down the Formica and applying another sheet of Formica. For desk and bureau tops, it will last at least twenty years, under normal conditions.

Most legs of the furniture are of wrought iron. This is very inexpensive and will last indefinitely.

Upholstery would be plastic or synthetic fibres which can easily be washed. Any curtains would be of synthetic fibres, allowing easy washing and long wear. The extra cost would be justified for this reason.
Costs were determined by an approximation of costs, if the pieces were made in large quantity or bought in large quantity if standard items on the market fit the requirements.

f. Efficiency calculations. The method is the same as that used for the married students' units:

Two bedroom apartments, average net rentable area

<table>
<thead>
<tr>
<th>Room</th>
<th>Square Feet</th>
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</thead>
<tbody>
<tr>
<td>Living Room</td>
<td>204 sq. ft.</td>
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<tr>
<td>Bedroom</td>
<td>130 &quot;</td>
</tr>
<tr>
<td>Bedroom</td>
<td>119 &quot;</td>
</tr>
<tr>
<td>Kitchen</td>
<td>70 &quot;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>524 sq. ft.</strong></td>
</tr>
</tbody>
</table>

One bedroom apartments, average net rentable area

<table>
<thead>
<tr>
<th>Room</th>
<th>Square Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living Room</td>
<td>200 sq. ft.</td>
</tr>
<tr>
<td>Bedroom</td>
<td>92 &quot;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>292 sq. ft.</strong></td>
</tr>
</tbody>
</table>

With twenty two-bedroom units and two one-bedroom units to each slice of three floors, the total net rentable area is 11,064 sq. ft. The total gross area for three floors comes out to be 20,320. When compared to the net rentable area, the efficiency is 54.45% - understandably lower than the 57.2% for the married students' building because of the single loaded corridor.

If these two buildings are considered as one the efficiency comes to:

- Two buildings - married and single - combined: 56.3%
- Eastgate: 55.1%
- Fresh Meadows: 50.1%

This comparison shows the "combined-married and single building" to be the most efficient of the three examples.
g. Public circulation and services. As mentioned above, the location of the vertical circulation was determined by the structural system and the fire stair regulations. The least possible space is wasted, particularly with the insertion of the small one bedroom units in the elevator bay. (Each of these has two exits, as required by code.) 

There is a laundry on the roof and a Snack Bar and Ping Pong Lounge on the main floor. The Snack Bar facilities could easily be closed and turned into a regular lounge if it were not profitable, though this seems unlikely. There would also be a laundry delivery service, but the food store would be located in the married students' building.

h. Height limitations. This problem corresponds to that faced in the other building and has been solved in a similar manner.

4. SITE PLAN

The site plan is divided up into three basic areas - there is the dormitory-apartment area, the married students' area and the fraternity area. This is the order in which they are placed, from east to west.

In all of the previous studies made in 1949 and 1950, the fraternities (as a separate wing of the larger complex), and the dormitory were considered as a single grouping and they were invariably located at the western end of the site. This was possible because, at that time, there was no thought of other buildings to be placed on the site and it was felt to be wise to leave the extension of the present playing fields as open and uncommitted as possible.

As my more recent examination of the problem has shown, there are now more problems and more buildings to consider. In fact, it seems that the

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1 See "New Dormitory" file in office of Professor Burnham Kelly, Associate Professor of City Planning.
site is so small for the requirements that there can be little space
left for future flexibility. (High units might be placed along the
western and northwestern border, if necessary, but it is not likely that
much more will be included on the site. The feasible exception might be
more high apartments.)

a. Fraternities. It now seems definite that the fraternities will
be moving onto the site and it also seems fairly certain that they would
not consider doing so if they were to be housed in a single high building.
This being the case, it seems correct to plan an area for them and expect
that they will use it. This is different from just leaving a large area
open for "playing" and assuming that it can later be used, somehow, for
fraternities. The space may be fine but its relationship to other spaces
and other buildings may be ruined once the fraternities are located there -
unless it has been well planned for and decided on. Wishful thinking will
not keep the space free of fraternities, though the site planner may hope
that the space he has said might be used for fraternities will remain open
and unharmed. As long as the fraternities will definitely be coming, I
feel it wiser to be more concerned with the total picture once they have
arrived than to enjoy the openness without them - grudgingly realizing
that there will be room for them when they move.

My site plan shows no definite scheme for the grouping of the fraternities
but the space left open for them is about eight and a half acres and pre-
sents a great deal of freedom in layout and orientation. Their arrival on
the site will not harm any of the previously calculated spaces, unless some
fraternities are located between Memorial Drive and the Low Houses. How-
ever, considering the ample yet defined exterior spaces formed by the low
units, the loss of the visual opening onto the river would not be unbearable.
It is obvious that not every portion of the site can maintain the river view, when one considers the shortage of land and the depth of the site.

b. The Twelve story Units. The dorm is located closest to campus for the quickest most direct circulation. It therefore becomes a part of the dorms already located along Amherst alley. It faces the river and turns its back to Vassar Street, screening the area in front of it from the noise and visual chaos.

(Aside from the design and sociological considerations, the reason for separating the two high buildings into two distinct buildings was that the dormitory would probably be tax exempt and the married students' apartment house would not be so rewarded, as they could not be classified as purely student housing.)

The Married High Unit, together with the Dorm-Apartment Unit, defines the end of the large area of playing fields. These buildings form a background for the fields as they are viewed from the direction of Mass. Avenue, and yet they are not so placed as to bottle up the area visually. The large opening between these buildings and the end of Burton House changes in shape and enlarges as the eastern limits of the playing fields are approached. Since all of the single students will have living rooms facing the river and since 63% of the living rooms in the married students' apartments will be facing the playing fields and have an oblique view of the river, the space in front of these buildings has been kept open for more playing fields. (A new baseball field was one of the requirements and at the suggestion of Professor Geiger, Head of the Department of Athletics, the baseball field was placed where the lacrosse fields are now located and the lacrosse fields were placed in front of the new buildings. Since they would be in use comparatively little, and since they require little fixed
equipment, such as goal posts, it virtually insures a generous green area which will form a pleasant foreground for the occupants of the apartments. The area will also be available to the occupants for play activities when it is not being used for lacrosse. Since both of the high buildings have main entrances facing this field, (besides the back ones that give access to the parking area), it is likely that the area will be alive with activity much of the year.

c. Low Units. The 96 low units are contained in five separate structures of varying length. They are grouped beyond the high buildings, so as to give them a good view and orientation and form interesting spaces with long and short vistas. The units are planned to provide the maximum of privacy and ease of circulation, being closely related to one another but never crowded. Since the occupants will also use the services of the main building such as the store, easy access from this side has been provided.

d. Parking and Roads. The parking area is concentrated in one four-car-wide strip along the back of the site. Four hundred spaces have been provided for 420 apartments. Since not all of the married students will have cars and since there may be several car owners in some of the single students' suites, it is hard to estimate the space required. However, it seems this total of four hundred may be generous. Certainly there will be other people to use it. The problem will not be vacancies but a system of control which will have to be worked out.

The Dormitory has the main lobby just off the parking lot and the same is true of married students' apartments, though the walk to the entrance here (which might be canopied) is over 200 feet south of the parking lot. Though this is the central core of the circulation in the married students'
apartments, there is an entrance and stairway at each end of the long building, with a passenger-service elevator at the end near the parking lot.

Walks lead to all of the three story units from the parking lot, and also lead directly onto Memorial Drive.

e. Access to the site from 77 Mass. Avenue. The final integration of the new redevelopment into the circulation complex of the campus has its limitations.

The new plaza leads to the playing fields and Amherst Alley which runs behind Baker and Burton House. Though it seemed essential at first, it will not be possible to run any sort of path of circulation across the present playing fields, even if this path were to run parallel to the present racing track. Since the redevelopment scheme will increase the student population at the eastern end of the campus by about four hundred, it seemed essential that something be done to supplement the sidewalk down Vassar Street and the narrow walk along Amherst Alley. As it is probable that the back entrances to the present Graduate House and Burton House will be improved, I propose that a wider walk, landscaped with trees, be extended the full distance from the southeast corner of the plaza to the far corner of the present tennis courts behind Burton House. For this purpose, an additional strip of fifteen feet can be trimmed from the southern boundary of the present playing fields.

Beyond this point in back of Burton House, I have extended Amherst Alley in a straight line to a point where the low married students' units end. Here it would make a turn north to Vassar Street, parallel and close to the sewer easement mentioned earlier. Finally, this would serve as a peripheral boundary and route of circulation for the easternmost low units and would define the edge of the large area to be devoted to fraternities in the future.
IV. THE ECONOMIC STUDY

1. The following is a study of the economic basis of my final solution:
   a. The total areas
   b. Cost of the project
   c. The operating cost
   d. The income required
   e. The source of income
   f. Cost comparisons and comments

It is a ticklish business to try to estimate the cost of a building when it has not been designed in complete detail and when the construction method is new to the area, though it would not be so at the time for which the building is planned.

Needing some basis on which to work, I have used many of the figures and percentages derived from an examination of the building costs and maintenance costs of Eastgate. Being a skip floor apartment house, built in this area and built in 1949, it provided many useful figures. Section C of the Appendix contains the figures used.

a. Total Areas (see Appendix D)

   Low Units      = 69,000 sq. ft.
   High Married Unit = 196,570 sq. ft.
   Single Student Unit = 89,750 sq. ft.
Choosing a square foot costs involved some of the most doubtful assumptions made.

The pages which give the data on Eastgate were carefully studied and then several other factors were considered. After this consideration, a figure - which at least has some basis in fact, was decided on.

The "several other factors" besides the Eastgate data were:

- The lift slab method has been incorporated as an integral part of the design.

- The cost of piles, because of the poor soil at Eastgate, amounted to 4.5% of the total cost of the project. It is most likely that the soil at Westgate will not cause any such unusual cost.

- There are more apartments per square foot in my project, because they are smaller in size. This will increase the cost of utilities, special equipment, and partitions per square foot. (Note, however, that the complete installation of the kitchen equipment - labor and materials, was only slightly over $500 per apartment so each of these items alone is no great increase.)

- The balconies at Eastgate were not added in computing the area of the building; I have not added this area either.

b. Project cost.

These were the figures I decided on:

Eastgate square foot cost ($12.97) adjusted by

Dodge index to $14.28, minus 12% for High Units = $12.56

and, minus 20% for Low Units = 11.42

Then, the cost of the project will be:
Low Units = 69,000 sq. ft. x $11.42 = $789,000

Married High Units = 196,570 sq. ft. x $12.56 = 2,470,000

Single Student High Units = 89,750 sq. ft. x $12.56 = 1,128,000

Total = $4,387,000

Adding to this, the cost of the furniture in the single students' apartments = 119,000

Grand Total = $4,506,000

Factors overlooked: I have not counted in the cost of tearing down the present buildings, the cost of extending the Institute steam lines, the paving, or any more landscaping than was counted in at Eastgate - a small site. It is hard to decide which of the above should be included in my project budget.

Another cost which I have not included, as it is difficult to allot the correct amount to the budget of my project is:

Site = 827,000 sq. ft.

Assessed value = $370,000

Tax (approximate) = $13,000

c. The Operating Cost - (See Appendix E).

The operating costs will amount to:

Maintenance = 3.25%

Real estate tax = 2.70%

Amortization = 5.05%

11.00% of the total cost of the project

(By including the cost of the furniture in the total project cost, the above maintenance and real estate tax percentages of the original cost of
the furniture will be more than ample to pay for the replacement necessary. It would be 5.95% of $119,000 or $7,100 per year.)

d. The Income Required.

The total project cost times the operating percentage gives:

\[ \$4,506,000 \times 11.00\% = \$496,000 \]

Since it is likely that no taxes would be paid on the single students' apartment-dormitory, there would be an annual saving of:

- cost of dorm building \( \times \) 2.70% (real estate tax rate),
- \( \$1,128,000 \times 2.70\% = \$30,500 \)

This reduces the income required to:

\[ \$496,000 - 30,500 \]

Total income required: \$465,500

e. The source of income.

Though I have not figured out the most economical way in which to operate the store in my project, I realize this might be a small source of income. However, I have chosen to concern myself, solely, with the income which would be derived from the rent of the apartments.

Rents which are considered reasonable by the present occupants of Westgate West, Westgate and the dormitories are:

1. A survey of the present occupants of the Westgates indicated that rents of $75 and $85 for the one and two bedroom apartments - including all utilities - would be reasonable for my projected scheme. However, there were a number of married students who felt that the rents should be closer to $50 and $60 dollars - or less - because of the financial burden borne by most of the students.
The present rents, including an estimate on the cost of utilities, are:

- **Two bedroom units, Westgate West**
  - (no refrigerators provided)  
  - $55

- **Two bedroom units, Westgate**
  - $75

- **One bedroom units, Westgate**
  - $63

2. It will be recalled that the average rents estimated by the single students were - $240 per term (by the occupants of Baker House) and $223 (by the occupants of East Campus and Burton House).

The present campus average dorm rent is $163 and the rents in Baker House are $190 per term.

---

The following are attempts to meet the operating costs with the proper rents. It will be noted that the rents and operating cost of both the married and single students have been grouped together. This amounts to a subsidy of the married students by the higher rents per apartment which are charged for the single students. The amount of this "subsidy" will be discussed later.

**Single Students**

- $190 per term, or $380 per year (8.65 months) = $380 x 334 students

**Married Students**

- 78 one bedroom units $65 per mo. x 12 mos. x 78 units = 60,600
- 249 two bedroom units $75 per mo. x 12 mos. x 249 units = 224,000
- 6 three bedroom units $85 per mo. x 12 mos. x 6 units = 6,120

$290,920
Through the years, there have been virtually no vacancies in the Westgates. The figure was 99.99% occupancy for 1952.

If I count on an occupancy of 99% (or 4 days vacancy per unit per year), the income becomes:

$290,920 \times 99\% = $287,700

Then:

**Single students** = $127,000

**Married students** = $287,700

This gives a deficit of:

- **Operating costs** = $465,500
- **Minus income** = $414,700
- **Deficit** = $50,800

An adjustment for breaking even:

- If the single students' rent is raised to $210 per term, their total rent rises $13,360.
- If the married students' rents are raised to $75, $85 and $95, their total rent rises $39,500.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>$13,360</td>
</tr>
<tr>
<td>Married</td>
<td>$39,500</td>
</tr>
<tr>
<td>Total Rise</td>
<td>$52,860</td>
</tr>
</tbody>
</table>

$13,360 plus $127,000 = $140,360
$39,500 plus $287,000 = $327,200

**New total rent** = $467,560

This wipes out the deficit
The single students' rents could be raised even more and the married students' rents could be lowered - or vice versa.

At any rate, the married students' rents, minus $6 a month for heat and $6 a month for electricity are still basically $63, $73 and $83 a month.

The adjusted rents for breaking even are the rents I will use for further analyses.

Also, any occupancy in the single students' apartments during the summer would help any deficit. There is sufficient separate storage in each apartment for students to lock and leave their possessions in the apartments, if they are planning to return in the Fall.

Another factor of prime importance to remember is that if any of the money for the project is given as a gift, or is borrowed at a lower rate of interest, the rents will drop correspondingly.

f. Cost comparisons and comments.

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Married High &amp; Low</th>
<th>Baker House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of units</td>
<td>87</td>
<td>333</td>
<td>-</td>
</tr>
<tr>
<td>Number of students housed</td>
<td>334</td>
<td>333</td>
<td>350</td>
</tr>
<tr>
<td>Cost of building, unfurnished</td>
<td>$1,128,000</td>
<td>$3,259,000</td>
<td>$2,299,723</td>
</tr>
<tr>
<td>Cost of building, furnished</td>
<td>$1,247,000</td>
<td>-</td>
<td>2,564,400</td>
</tr>
<tr>
<td>Cost per apartment, unfurnished</td>
<td>$12,980</td>
<td>$9,780</td>
<td>-</td>
</tr>
<tr>
<td>Cost per apartment, furnished</td>
<td>$14,330</td>
<td>$9,780</td>
<td>-</td>
</tr>
<tr>
<td>Cost per square foot, unfurnished</td>
<td>$12.56</td>
<td>$12.29</td>
<td>$16.93</td>
</tr>
<tr>
<td>Cost per square foot, furnished</td>
<td>$13.89</td>
<td>-</td>
<td>18.90</td>
</tr>
<tr>
<td>Square feet per building</td>
<td>$89,750</td>
<td>265,570</td>
<td>135,650</td>
</tr>
<tr>
<td>Gross sq. ft. per apartment</td>
<td>1032</td>
<td>795</td>
<td>-</td>
</tr>
<tr>
<td>Square feet per student</td>
<td>269</td>
<td>795</td>
<td>388</td>
</tr>
<tr>
<td>Cost of furniture</td>
<td>$119,000*</td>
<td>-</td>
<td>$264,677</td>
</tr>
<tr>
<td>Cost of furn. per 1 bedrm. apt.</td>
<td>$915</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cost of furn. per 2 bedrm. apt.</td>
<td>$1,400</td>
<td>-</td>
<td>756</td>
</tr>
<tr>
<td>Cost of furniture per student</td>
<td>$356</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average rent per apartment per year</td>
<td>1615</td>
<td>978</td>
<td>-</td>
</tr>
<tr>
<td>Building cost per student, unfurnished</td>
<td>3,380</td>
<td>9,780</td>
<td>6,570</td>
</tr>
</tbody>
</table>

* Cost of furniture in Snack Bar has not been included.
<table>
<thead>
<tr>
<th>Building cost per student, furnished</th>
<th>Single</th>
<th>High &amp; Low</th>
<th>Baker House</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3,736</td>
<td>-</td>
<td>$7,327</td>
<td></td>
</tr>
<tr>
<td>Total income per year per bldg.</td>
<td>140,000</td>
<td>$327,000</td>
<td>$133,000</td>
</tr>
<tr>
<td>Income, percentage of building cost</td>
<td>8.3</td>
<td>11.0</td>
<td>5.3</td>
</tr>
<tr>
<td>Rent per student per term</td>
<td>$210</td>
<td>-</td>
<td>$190</td>
</tr>
<tr>
<td>Rent per student per year</td>
<td>$420</td>
<td>$978</td>
<td>$830</td>
</tr>
<tr>
<td>Rent per student per term-month (8.65 months) (Campus av. in dorms = $37.70)</td>
<td>$48.60</td>
<td>-</td>
<td>$43.90</td>
</tr>
<tr>
<td>Rent per one bedroom unit per year</td>
<td>$840</td>
<td>$900</td>
<td>-</td>
</tr>
<tr>
<td>Rent per two bedroom unit per year</td>
<td>$1600</td>
<td>$1020</td>
<td>-</td>
</tr>
<tr>
<td>Rent per three bedroom unit per year</td>
<td>-</td>
<td>$1140</td>
<td>-</td>
</tr>
<tr>
<td>Rent per one bedrm. unit per term-mo.</td>
<td>$97.20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rent per two bedrm. unit per term-mo.</td>
<td>$194.40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rent per one bedrm. unit per mo. (rent spread over 12-mo. period)</td>
<td>-</td>
<td>$70</td>
<td>-</td>
</tr>
<tr>
<td>Rent per two bedrm. unit per mo. (rent spread over 12-mo. period)</td>
<td>-</td>
<td>$140</td>
<td>-</td>
</tr>
<tr>
<td>Rent per one bedrm. apt. per mo.</td>
<td>-</td>
<td>$75</td>
<td>-</td>
</tr>
<tr>
<td>Rent per bedrm. apt. per mo.</td>
<td>-</td>
<td>$85</td>
<td>-</td>
</tr>
<tr>
<td>Rent per three bedrm. apt. per mo.</td>
<td>-</td>
<td>$95</td>
<td>-</td>
</tr>
<tr>
<td>Total rent necessary for dorm apts. if tax free and not &quot;subsidizing&quot; married students per term per student</td>
<td>$106,700</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Amount of subsidy per year that is being paid by single students per term per student</td>
<td>$33,660</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total income necessary for married students' units (at 11%)</td>
<td>-</td>
<td>$359,000</td>
<td>-</td>
</tr>
<tr>
<td>Total income necessary here, per apt.</td>
<td>-</td>
<td>$1,078</td>
<td>-</td>
</tr>
<tr>
<td>Total actual income, married building per apartment</td>
<td>-</td>
<td>$327,000</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>$978</td>
<td>-</td>
</tr>
</tbody>
</table>

The combination of two types of apartment buildings - for single and for married students - seems to be one solution to the problem of making low rent housing for married students feasible. Only one of fifty single students objected to the principle, when interviewed.
VI. IN CONCLUSION

I have tried to demonstrate a way in which the necessary additions to the housing and recreation facilities that will be needed in the future can be planned for and combined on the site now occupied by Westgate West and Westgate.

Since the cost of any such problem is a major obstacle, I have attempted an examination of these costs, and a possible solution to the problem. Though a great many points have been considered, the soundness of the conclusions may not always be completely justified. However, it is through a realization of what the influencing factors are, and an examination how these factors have been considered, that errors in judgment can be spotted and adjusted.

In any such problem, the general concept is the most important. Though the economic analysis may be off by ten per cent or more, it presents a method of analysis. Through the reexamination and adjustment of each error, the validity of the entire problem can be judged.
APPENDIX A

Figure 4

Erect column 29'
Pour slabs on base slab
Brace column at 29' for lifting
Raise 6, 5, 4 in that order and pin
Raise and fix 3
Raise and fix 2
Raise and fix 1
Remove lifting jack
Raise and fix 6 from A
Spike column at A to final height
Replace lifting jack
Place top bracing and remove intermediate bracing

"Multistory and rigid frame analysis. The Youtz-Slick Method of Building Construction is not limited by any considerations to one- or two-story construction. It is entirely possible that 10 stories could be lifted and still be structurally sound and economical. The proposed lifting plan for a six-story office building is indicated by straight line diagrams (Figure 4). The columns are on 18-ft. centers and the slab is 6 in. of prime concern, of course, is the stability of the columns when the total length of column from roof top to footing is 54 ft. It was found that a column formed from two angles into a box shape with a nominal 8 in. by 8 in. section was adequate in the final loaded condition. It was felt that a section larger than that would become uneconomical in the final overall cost picture. When lifting loads were analyzed, it was found that it would be impossible to lift the roof slab the entire 54 ft. and fix it. However, after a few trials it was found that it would be possible to lift from approximately 29 ft. and pin three slabs and hold them there while lifting and fixing the first three floors as indicated (Figure 4). The columns are braced adequately at the 29 ft. point before lifting starts. In this instance with the column braced, the initial lift is carried out with one end fixed and the other end pinned. There is restraint against translation provided by the bracing. The roof slab is lifted and pinned to the column. This can be done by actually pinning through the column, or by welding seats on the column and sitting the slab on these seats. The same steps are followed with the fifth floor and the fourth floor. When the third floor is raised
to position it is welded into position. The second and first floors are handled in the same manner as the third floor. When the first floor is complete, the lifting jack is removed and the remaining height of a column is spliced to the existing section. This splice should occur at a point on the column between one-quarter and one-half of the finished floor-to-floor height of column. After splicing, the remaining slabs are lifted and fixed in place in reverse order: roof, fifth floor, and fourth floor.

During lifting, certain precautions should be taken; adequate provision against wind acting on the exposed slab edges should be maintained, particularly when the upper slabs are pinned. Adequate bracing during the initial lift should exist so that buckling does not occur at any time. It is necessary to check column strengths for all conditions of loading, including the final loaded condition.

The rigidity of multistory building is of prime importance. The wind load and the resisting stresses should be calculated for the finished building as well as during erection. The actual analysis for wind stresses is solved differently for every building because of building codes, height of building, and the width and length of building. However, certain fundamental investigations should be made. These investigations would, of course, be more critical across the short direction of the building where the wind forces are offered the large exposed surface area of the long dimension. The prime concern is the connection made between columns and footings. The bolts and welded connections should be of sufficient strength to take the added horizontal thrusts due to wind. When the building resists wind pressure it acts similar to a cantilevered truss and, of course, is held in position by the vertical load and the connections at the base. Generally, there is no danger of the building overturning, but racking of the geometrical frame must be carefully checked. The racking tendency is resisted by the stiffness of the columns, and slabs acting as a bent; hence an adequately rigid joint must be provided at the column-slab connection. This is done by welding the collar directly to the column on top and bottom, as well as the shear connector provided, as mentioned previously. In order to insure even greater rigidity, it is suggested that the reinforcing in the slab be welded to the collar wherever practical. Racking tendencies due to horizontal load can also be aided by shear walls constructed in the direction of the short dimension of the building. Partitions and exterior walls also aid in the reduction of racking; however, this resistance is variable and should not be counted on too heavily. The horizontal displacement of one story relative to the next should be considered and the columns checked to insure that they are capable of resisting this displacement.

The Youzt-Glick Lift-Slab Method is applicable to multistory construction; certain elementary precautions must be taken, of course, but the method lends itself admirably.  

---

### APPENDIX B

**Description of Furniture for the Dormitory-Apartments**

<table>
<thead>
<tr>
<th>Items</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 desks</td>
<td>$150.00</td>
</tr>
<tr>
<td>4 beds</td>
<td>180.00</td>
</tr>
<tr>
<td>4 mattresses</td>
<td>180.00</td>
</tr>
<tr>
<td>4 closet-bureaus</td>
<td>150.00</td>
</tr>
<tr>
<td>4 small wall suspended bookcases</td>
<td>60.00</td>
</tr>
<tr>
<td>6 desk and dining chairs</td>
<td>150.00</td>
</tr>
<tr>
<td>1 coffee table</td>
<td>10.00</td>
</tr>
<tr>
<td>3 easy chairs, $55, $35, $25</td>
<td>115.00</td>
</tr>
<tr>
<td>1 sofa</td>
<td>125.00</td>
</tr>
<tr>
<td>1 rug</td>
<td>75.00</td>
</tr>
<tr>
<td>1 dining table</td>
<td>20.00</td>
</tr>
<tr>
<td>1 stool</td>
<td>4.00</td>
</tr>
<tr>
<td>4 desk lamps</td>
<td>30.00</td>
</tr>
<tr>
<td>2 table lamps</td>
<td>15.00</td>
</tr>
<tr>
<td>1 standing lamp</td>
<td>6.00</td>
</tr>
<tr>
<td>1 bookcase for living room</td>
<td>35.00</td>
</tr>
<tr>
<td>Shades or curtains</td>
<td>95.00</td>
</tr>
<tr>
<td>Total</td>
<td>$1,400.00</td>
</tr>
</tbody>
</table>

**Description of Furniture**

**Desks** - 2' x 4' Formica top with mitred edges, wrought iron legs at one end with a four drawer unit with toe space beneath at the other end.

**Beds** - wrought iron frames with springs, short legs, Hollywood bed style. Vertical pieces fit onto frames and make two singles into one double, for flexibility in room arrangement.

**Closet-Bureau** - in addition to built in shelves above hanging rod. These units would provide "trays" of varying size for clothes storage. Each unit would be 2' - 6" high and 15" x 24". The two units would stand, one on top of the other, in the closet, leaving ample hanging space. Then, when "bureaus" were moved into a room with four beds, they would be lined up to form an 8' long (Formica Top) bank of drawers. These would be placed on a four-inch-toe-space-providing frame resting on the floor.
Coffee table and stool - both of Formica and wrought iron.

Sofa - wrought iron frame, webbing, foam rubber mattress and bolster cushions. Removable orlon-wool slip covers.

Dining and desk chairs - wrought iron legs and back supports. Foam rubber seat and back covered with washable fabric or plastic.

Lamps - All types, mad with metal and fibreglass or plastic shades.

Easy Chairs - Again, stainless steel or wrought iron legs, washable fabrics or plastic, including a Hardoy chair with some sort of synthetic material sling.
## APPENDIX C

**Cost Report on 100 Memorial Drive**  
**June 27, 1951**

**Contract Budget** 10-28-48 (includes Apartment and Garage) without Fee  
\[ \text{Total} = \$3,140,650.00 \]

**Change Orders (98):**
- Add: \[ \$334,368.79 \]
- Transfer from Continency Fund: \[ \$69,138.84 \]
- Deduct: \[ \$399,507.63 \]

**Net Addition**  
\[ \text{Total} = \$342,436.86 \]

**Contract Budget plus Changes**  
\[ \text{Total} = \$3,483,086.86 \]

**Underrun (75% return to NEM)**  
\[ \$289,791.69 \]

**Construction Cost**  
\[ \text{Total} = \$3,193,295.17 \]

**Contractor's Fee:**
- Contract Fee: \[ \$145,000.00 \]
- Additions during constr.: \[ \$370.32 \]
- 25% of Underrun: \[ \$72,447.92 \]

**Total Food**  
\[ \text{Total} = \$217,818.24 \]

**Total Payment on Contract**  
\[ \text{Total} = \$3,411,113.41 \]

**Miscellaneous Construction Costs**
- Carpentry, TV Antenna System, Kitchen Fans, etc.: \[ \$84,169.01 \]
- Carrying Charges: \[ \$38,356.87 \]
- Architects', Engineers' and Consultants' Fees (6.1%): \[ \$235,501.82 \]

**Total Cost to June 13, 1951**  
\[ \text{Total} = \$3,769,141.11 \]

**Other Figures Used:**
- Cost of total project minus garage per square foot: \[ \$3,577,000 = \$12.97 \]
- This same figure, adjusted by the Dodge Index: \[ \$3,934,700 = 14.28 \]

**Total number of apartments** (counting the Compton Penthouse as 3 apartments):  
\[ 263 \text{ apartments} \]

**Cost per apt. (using adjusted figure, not including cost of garage):**  
\[ \$14,950 \]

**Cubage:**  
\[ 2,650,232 \]

**Sq. Ft.** (without garage, sq. ft. = 275,000 (approx.)):  
\[ 295,389 \]
### Breakdown of Contract Cost - from Fuller Construction Company

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Conditions</td>
<td>$149,161</td>
</tr>
<tr>
<td>Excavation</td>
<td>47,886</td>
</tr>
<tr>
<td>Foundation (substructure)</td>
<td>58,418</td>
</tr>
<tr>
<td>Piles, concrete and wood</td>
<td>168,600</td>
</tr>
<tr>
<td>Masonry</td>
<td>217,000</td>
</tr>
<tr>
<td>Waterproofing, Dampproofing and Caulking</td>
<td>34,742</td>
</tr>
<tr>
<td>Reinforced concrete (superstructure)</td>
<td>757,560</td>
</tr>
<tr>
<td>Floor fills and finishes</td>
<td>77,635</td>
</tr>
<tr>
<td>Terra Cotta and Gypsum Fire partitions</td>
<td>57,551</td>
</tr>
<tr>
<td>Metal furring, lath and plaster</td>
<td>236,900</td>
</tr>
<tr>
<td>Millwork</td>
<td>20,139</td>
</tr>
<tr>
<td>Wood doors</td>
<td>32,575</td>
</tr>
<tr>
<td>Rough carpentry and Millwork Erection</td>
<td>109,269</td>
</tr>
<tr>
<td>Roofing and Sheet Metal</td>
<td>14,538</td>
</tr>
<tr>
<td>Enamelled Metal Work</td>
<td>3,496</td>
</tr>
<tr>
<td>Kalemein Doors</td>
<td>13,565</td>
</tr>
<tr>
<td>Meter Closet Doors</td>
<td>1,840</td>
</tr>
<tr>
<td>Delivery Doors</td>
<td>3,560</td>
</tr>
<tr>
<td>Hollow Metal Doors and Frames</td>
<td>31,978</td>
</tr>
<tr>
<td>Toilet Stalls</td>
<td>240</td>
</tr>
<tr>
<td>Glass and Glazing</td>
<td>29,141</td>
</tr>
<tr>
<td>Painting and Decorating</td>
<td>65,446</td>
</tr>
<tr>
<td>Ornamental and Miscellaneous Ironwork</td>
<td>85,172</td>
</tr>
<tr>
<td>Finished Hardware</td>
<td>26,808</td>
</tr>
<tr>
<td>Plumbing, Heating and Ventilating</td>
<td>134,472</td>
</tr>
<tr>
<td>Electric wiring and Fixtures</td>
<td>132,303</td>
</tr>
<tr>
<td>Elevators and Enclosures (three elevators)</td>
<td>68,400</td>
</tr>
<tr>
<td>Overhead Doors</td>
<td>750</td>
</tr>
<tr>
<td>Metal Sash and Screens</td>
<td>66,854</td>
</tr>
<tr>
<td>Grouting of Sash</td>
<td>9,200</td>
</tr>
<tr>
<td>Slate Window Stools</td>
<td>5,956</td>
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<tr>
<td>Ceramic Tile Work</td>
<td>22,736</td>
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<tr>
<td>Floor Covering</td>
<td>66,149</td>
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<tr>
<td>Kitchens (labour and materials)</td>
<td>134,809</td>
</tr>
<tr>
<td>Mailbox</td>
<td>1,565</td>
</tr>
<tr>
<td>Yardwork and landscaping</td>
<td>42,368</td>
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<tr>
<td>Incinerator</td>
<td>869</td>
</tr>
<tr>
<td>Fire Extinguishers</td>
<td>1,719</td>
</tr>
<tr>
<td>Winter Conditions</td>
<td>29,280</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$3,199,507</td>
</tr>
</tbody>
</table>

Fee: 145,000
Total: 3,391,650
Contingencies: 106,000
Total: 3,391,650

Deduct cost of garage (including fee and conting.: 192,143

Contract Cost of building proper = $3,199,507
APPENDIX D

Areas

Low Married Students' Units:

Two bedrm. unit is 28' x 23'-10" = 667 plus 40 = 707 x 90 units = 63,600
Three bedrm. " 32' x 26'-10" = 860 plus 40 = 906 x 6 units = 5,400
Total square feet = 69,000

(Note: This additional 40 square feet was considered equivalent to the cost of an apartment's internal stairway plus the cost of a balcony, in the Eastgate calculations. Since similar additional items are attached to the Low Unit apartments, I have added the 40 square feet to my gross areas.)

High Married Students' Units:

34'-4" x 21'-4" x 20 col. bays long x 12 floors = 175,700

add to this figure of the basic mass of the building the following additional areas:

8' x 31' x 12 floors (stairs near parking lot) = 2,980
8' x 22' x 12 floors (stairs at southern end) = 2,110
40' x 76' x 2 floors (main lobby and store area) = 6,080
Boiler Room
Laundry on roof = 800
Galleries connecting two wings, 8' x 60' x 3 = 1,440
Two vertical circulation stacks at center of building, 8' x 31' x 2 x 12 floors = 5,960

Total Square Feet = 196,570

Single Students' Dormitory-Apartments

28'-10" x 25'-6" x 12 floors x 9 col. bays long = 79,300
Stairs at west end, 20' x 8' x 12 floors = 1,920
Laundry on Roof = 800
Lobby and Snack Bar, etc. area = 7,730

Total Square Feet = 89,750
APPENDIX E

Operating Costs

Maintenance and Taxes

Eastgate total project cost (minus garage) as of June 1951 = $3,577,000

Operating costs in 1952 were:

\[
\begin{align*}
\text{minus factors will not have to consider} & \quad \text{(ground rent of $3,200)} \\
\text{\quad (garage maint. 3,096)} & \quad \text{(TV install. & 1,300)} \\
\text{\quad advertising $7,596)} & \quad \text{- 7,596} \\
\hline
\text{Minus real estate tax} & \quad 108,535 \\
\text{Total Maintenance Cost} & \quad 102,832
\end{align*}
\]

Then, $102,832 = \text{Maintenance cost, 1952} = 2.85\% \text{ project cost}$

$108,535 = \text{Tax, 1952} = 2.88\% " "

Breakdown of Maintenance

<table>
<thead>
<tr>
<th>Category</th>
<th>1952</th>
<th>1951</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative</td>
<td>$14,925</td>
<td></td>
</tr>
<tr>
<td>Grounds Maintenance</td>
<td>3,124</td>
<td></td>
</tr>
<tr>
<td>Utilities: Water</td>
<td>2,518</td>
<td></td>
</tr>
<tr>
<td>\quad Elec.</td>
<td>3,746</td>
<td></td>
</tr>
<tr>
<td>\quad Heat</td>
<td>23,527 (23,107)</td>
<td></td>
</tr>
<tr>
<td>Employ. Benefit tax, etc.</td>
<td>2,330</td>
<td></td>
</tr>
<tr>
<td>Gen. Labor (Janitors, etc.)</td>
<td>27,800 (25,600)</td>
<td></td>
</tr>
<tr>
<td>&quot; Supplies</td>
<td>3,971 (3,700)</td>
<td></td>
</tr>
<tr>
<td>&quot; Equipment</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Rubbish removal</td>
<td>178</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1,426</td>
<td></td>
</tr>
<tr>
<td>Electric repairs</td>
<td>1,356 (431)</td>
<td></td>
</tr>
<tr>
<td>Heating repairs</td>
<td>214 (303)</td>
<td></td>
</tr>
<tr>
<td>Plumbing repairs</td>
<td>1,704 (932)</td>
<td></td>
</tr>
<tr>
<td>Elevator repairs</td>
<td>2,281 (2,435)</td>
<td></td>
</tr>
<tr>
<td>Structural (interior)</td>
<td>440</td>
<td></td>
</tr>
<tr>
<td>&quot; (exterior)</td>
<td>247 (100)</td>
<td></td>
</tr>
</tbody>
</table>

(Note: The figures in brackets are 1951 figures, when available.)

I have considered the above costs as being constant over the years. They will not increase with the age of the building, to any great extent, though the plumbing, elevators, etc., will eventually have to be partly replaced.
The only remaining maintenance costs are:

Outside painting 5,807  (none in 1951)
Interior Decorating 7,718  (1,800)

$13,525

These two items are the ones which will fluctuate the most but they only amount to 13.5% of the total maintenance cost. I will say that the average cost of these items over the years would not be over $15,000.

Two other items must be adjusted before the Eastgate maintenance figures can become a basis for my estimates.

1. Electricity. Since my tenants will not be separately metered, I am adding a reasonable electric bill to Eastgate's present expenses. With 263 apartments (counting the penthouse as 3) a year's bill might be:

(with 5% vacancies, which would be the same as having 87 of my apartments - the single students - empty for the summer) -

$6.00 x 12 months x 263 units x 95% = $18,000

2. Heating. Rough calculations indicate that, (considering my units have about 25% more glass area per apartment and have about 19% less cubage per apartment, and considering that M.I.T. steam is 21% less than Cambridge steam,) the cost of heating would be about $5,000 less than the 1952 figure of $23,527, or

$23,527

$5,000

$18,527

This is a 21% drop. With 263 apartments this is about $72 a year for heating or $6 a month per unit.

To adjust the Eastgate bill, then,
- outside painting and interior decorating will be increased from $13,525 to $15,000.
- electricity bills will add on $18,000.
- the heating bill will drop to $18,527.

These changes bring the total up $14,475, or from $102,832 to $117,307.

$117,302 = 3.28% of the total project cost.

(A point to consider. Building costs have gone up 10% in the past four years so if Eastgate were replaced today and the maintenance costs were assumed to be the same, they would constitute a smaller percentage of the total project cost. The drop would be from 3.28% to 2.98%. In other words, if I am basing my maintenance costs on the original cost of my new project, I feel it would be reasonable to consider this point. However, my project will cost less because of lift slab - and this fact will not contribute to lower maintenance.

With all these hard-to-determine factors to consider, I have chosen 3.25% for maintenance cost, merely rounding out the figure of 3.28%. Thus, the total operating costs will be an easy-to-work-with figure of 11%.

Real Estate Tax

The real estate tax this past year came to 2.88% of the total project cost.

Here is how that percentage figure has fluctuated during the years.

1950 - 2.44  
1951 - 2.34  
1952 - 2.88  Average is 2.57
1953 - 2.64  

Having no better basis for judgment, I shall guess a future average of 2.70%.
Financing. Since I am counting on a 40-year amortization at 4%, this will require 5.05% (of the total project cost) per year.

Total operating costs.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
<td>3.25</td>
</tr>
<tr>
<td>Taxes</td>
<td>2.70</td>
</tr>
<tr>
<td>Amortization</td>
<td>5.05</td>
</tr>
<tr>
<td></td>
<td>11.00%</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY


"Housing From the Tenant's Viewpoint", by Elizabeth Coit, Architectural Record, Vol. 91 (1942), April, pp. 71-84.


"Progressive Architecture", by Fred E. Koebel, February 1953, p. 93. ("Structural Aspects of Lift Slab").

"Lift Slab Housing", Architectural Forum, September 1951, p. 186.

"The Youtz-Slick Lift Slab Method of Construction", published by The Institute of Inventive Research, P. O. Box 2296, San Antonio, Texas.

"Youtz-Slick Lift Slab Building Method", reprint from Architectural Forum, June 1950.

"Eastgate Apartments", as a Fresh Plan Type, Architectural Record, February 1949, p. 107.

Files of George A. Fuller Construction Company, Boston, Mass.


"100 Memorial Drive" Files, Investment Department, New England Mutual Life Insurance Company.

"New Dormitory" File, Office of Burnham Kelly, Associate Professor of City Planning.


Hayes, H., "Planning Residence Halls for Undergraduate Students".


"How to Keep Your Feet on the Ground and Build a Roof", Business Week, August 23, 1952.


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GROUND FLOOR PLAN

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SCALE 1/8"=1'-0"

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