A FLEXIBLE SYSTEM FOR
OLYMPIC VILLAGES

by

SE-HACK CHUNG

Bachelor of Science in Architecture
Seoul National University,
Korea, 1981

Master of Science in Urban Engineering
Seoul National University,
Korea, 1983

SUBMITTED TO THE DEPARTMENT OF ARCHITECTURE IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN
ARCHITECTURE STUDIES

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June, 1985

© Se-Hack Chung 1985

The author hereby grants to M.I.T. permission to reproduce and
to distribute publicly copies of this thesis document in whole
or in part.

Signature of Author

Se-Hack Chung
Department of Architecture
May 10, 1985

Certified by

Eric Dluhosch
Associate Professor of Building Technology
Thesis Supervisor

Accepted by

Julian Beinart, Chairman
Department Committee on Graduate Students
A FLEXIBLE SYSTEM FOR
OLYMPIC VILLAGES

BY
SE-HACK CHUNG

Submitted to the department of Architecture on May 11, 1985 in
partial fulfillment of the requirements for the degree of
Master of Science in Architecture Studies

ABSTRACT

This thesis suggests a flexible system and its systems
approach in constructing Olympic Villages which are used both
during and after the Games.

A historical overview of ancient Olympia and modern
Olympia, as well as a case study of modern Olympic Villages
deal with the conceptual problem which were arisen in the
design of Olympic Villages, due to the conflict between
monumentality and practicality, and the contextual problems,
caused by the pressure of time and cost in the building
process.

An approach to appropriate patterns proposes the
construction of high-rise buildings and solves secondary
problems in design and construction. A conceptual approach
suggests perceptional complexity and flexibility. A
contextual approach suggests the systems approach for fast
track development which is compared with the conventional
building process.

Analogies of some notable building systems and their
approaches in the past development of systems suggest an open
system, a dual structure and performance based programming as
the strategy for designing and building future Olympic
Villages.

Thesis Supervisor: Dr. Eric Dluhosch
Title: Associate Professor of Building Technology
ACKNOWLEDGEMENTS

-----THANKS TO MY GOD, JESUS!------

To my parents!

To my advisor, Eric!

To my wife, Seung-Hee!

To my friend, Woo-Hyun!

THANKS.

Without their help, I might not even stand on this place.
**TABLE OF CONTENTS**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>2</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td></td>
</tr>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>1. OLYMPIC VILLAGE</td>
<td></td>
</tr>
<tr>
<td>1.1 Introduction</td>
<td>6</td>
</tr>
<tr>
<td>1.2 Historical Development</td>
<td>9</td>
</tr>
<tr>
<td>1.2.1 Ancient Olympia</td>
<td>10</td>
</tr>
<tr>
<td>1.2.2 Modern Olympia</td>
<td></td>
</tr>
<tr>
<td>1.2.3 Modern Olympic Village</td>
<td>11</td>
</tr>
<tr>
<td>1.3 General Goals and Requirements</td>
<td>24</td>
</tr>
<tr>
<td>1.3.1 Goals</td>
<td></td>
</tr>
<tr>
<td>1.3.2 Requirements</td>
<td>25</td>
</tr>
<tr>
<td>1.4 Problems</td>
<td></td>
</tr>
<tr>
<td>1.4.1 Conceptual Problem</td>
<td>34</td>
</tr>
<tr>
<td>1.4.2 Contextual Problem</td>
<td>35</td>
</tr>
<tr>
<td>2. APPROACH</td>
<td></td>
</tr>
<tr>
<td>2.1 Patterns</td>
<td>45</td>
</tr>
<tr>
<td>2.1.1 High-Rise or Low-Rise</td>
<td></td>
</tr>
<tr>
<td>2.1.2 Construction</td>
<td></td>
</tr>
<tr>
<td>2.1.3 Secondary Problems</td>
<td></td>
</tr>
<tr>
<td>2.2 Concept</td>
<td></td>
</tr>
<tr>
<td>2.2.1 Flexibility</td>
<td></td>
</tr>
</tbody>
</table>
1.1 Introduction

Most of the Olympic Games in the recent past have been occasions for creating architectural and technological innovations, ranging from sports complexes to urban infrastructures. But, as the scale of Olympic projects becomes larger, the difficulty in delivering the projects successfully under the pressure of deadlines and cost becomes greater. The building process of the Olympic Village in particular is constrained by this pressure, which is due to the dual purposes of use for both during and after the Games. Therefore this thesis suggests a flexible system and an systems approach to achieve flexibility in constructing Olympic Villages; this flexible systems approach is an architectural and technological strategy to solve the problems due to time and cost constraints and the pressure for subsequent dual purposes of use.

This study is largely concerned with a problem-seeking process and a problem-solving process, using the following strategy:

(1) A historical overview of ancient Olympia and modern Olympia, as well as a case study of modern Olympic Villages in section 1.2, shows the qualitative needs and quantitative needs that the planning of the Olympic Villages should fulfill. These needs indicate general goals and requirements of planning the Olympic Villages, discussed in section 1.3.
The case study of modern Olympic Villages sub-section 1.2.3 particularly shows that building problems result from a conflict between monumentality and practicality and from contextual problems related to time and money in a building process.

(2) In order to solve these problems, the study in Chapter 2 takes the three following approaches, which are explained with a consideration of the related resources of land, financing, management, technology and labor:

a) A case study of the modern Olympic Villages shows a typical typology - a high-rise building with variety. A high-rise building proposed by the relation to the planning approaches - centralized planning and decentralized planning. The cost implication of a high-rise building necessitates the use of an industrialized construction method, thereby indicating an desirable design process.

b) The relationship of the perception of form and function to conceptual problem - a conflict between monumentality and practicality - suggests complexity and flexibility, so that the perception would have much meaning in our value system.

c) A comparison between the fast-tracking building process and the conventional building process in terms of cost and time, suggests a systems approach which is appropriate for fast-track.

(3) Responding to the above three assumptions, a strategy of search by analogy for a flexible system and its systems approach has been adopted in chapter 3. Considering the relationship between technology and architecture in systems, flexible systems are compared to "cloudlike" systems. Examining each type of flexible system in terms of
generating and operating flexibility, the "chess analogy" for open systems is suggested.

(4) An open system, responding to the systems approach as a "chess analogy", is thus regarded as the appropriate flexible system for Olympic Villages. Some desirable considerations for developing such a system are discussed in the following pages.

All the information related to the examples of the various systems and past Olympic Villages will not be fully integrated in this thesis. That is, much as detailed technical information as it is not relevant to the choice of an overall strategy for generic approach, rather than a specific design, will not be discussed. However, the information which is assumed to be related to this process of this thesis, has been rationalized in order to achieve the goal of this thesis.
1. OLYMPIC VILLAGE

1.1. Introduction

1.2. Historical Development
   1.2.1. Ancient Olympia
   1.2.2. Modern Olympia
   1.2.3. Modern Olympic Villages

1.3. General Goals and Requirements
   1.3.1. Goals
   1.3.2. Requirements

1.4. Problems
   1.4.1. Conceptual Problems
   1.4.2. Contextual Problems
1.1. Introduction

Buildings and monuments, especially those for historical Olympic events, reflect the attitude and the intention of those who hold these events. Moreover, the very conditions of their times and the prevailing economic, social, and cultural needs are reflected by those architectural witnesses.

The case study of past Olympic Villages is made by taking the following factors into consideration: the super scale Sports Complex, and the context involved in implementing the project. The results reveal the character and problems of planning an Olympic Village. Hopefully, this study will indicate some direction for planning for the future in order to respond to new requirements and needs from the accommodation of social changes.
1.2 Historical Development of Olympic Villages

1.2.1. Ancient Olympia

The origin of modern Olympic Games can be traced from ancient times - Greece and Rome, 2000 to 2500 years ago. Because of the ancient concerns about physical and military exercises, dances, gymnastics, and games, the architects had to cope with varied social needs. With the fundamental Olympic idea of respect for man and human dignity in mind, the ancient Olympic complex was first and foremost a place for worship. Culture, sports buildings, and other facilities followed. Even today the general arrangement and the layout of the site of ancient Olympia provide stimuli for planning the sports and cultural buildings of the modern Games.

The ancient Olympic structures (Fig.1) consisted of the stadium and the hippodrome, which were the first contest facilities, as well as the athletic arena, the swimming pool and public baths, and the palestra, which were the educational institution. The structures were arranged within "a short walk" from the center of Altles, the Sacred Grove, which was in harmony with the natural environment and which took future expansion into consideration. Separated from the functions of administration, worship, the other functions of culture, transport, catering, and accommodation were located on the outskirts of the city. (Wimmer, 1976)
(Fig.1 Olympia plan of the site and environs about A.D. 200)

1. Olympia, plan of the site about A.D. 100
2. Temple of Zeus, 3. Pelopion, 4. Heraeum,
5. Meroum, 6. Stadium, 7. Echo Portico,
8. Bouleuterion, 9. Leonidaeum, 10. Theokoleon,
15. Altis wall, 16. Altar of Zeus

2. Olympia, environs about A.D. 200
10. Starting line, 11. Grandstand
The transport, catering, and accommodation facilities were essentially mobile - consisting of awnings and tents. It was therefore only in part the climate which allowed the visitors of the Games - originally lasting two days, and since 468 B.C., no more than five days - to spend the night in the open. The practical mind of the Greeks made them put up and maintain only such buildings as served the Games directly and permanently in their four-year Olympiad cycle and the religious ceremonies in the Sacred Precincts. For such short-time use, provisional arrangements had to suffice. Equally, the contestants themselves grouped according to the respective city states, had to make do with their accommodations in a temporary tent camp, not far from the Sacred Grove.

The tent camps were used for quite different purposes, which has had repercussions until the present on the planning of the modern Olympic Villages (Martin Wimmer, 1976)

-- They enabled intensive training for the specified period of time.
-- They accommodated the athletes together with their teachers in simple quarters.
-- They provided the same diet for everybody.
-- They ensured control of prescribed hygiene.
-- They controlled the observance of truce or peace among the athletes as stipulated by treaties.
-- They provided many opportunities for social contact and talks.
1.2.2 Modern Olympia

1,500 years after ancient Olympia, the spiritual, ethical, and aesthetic implications of the ancient Games were revived in 1896 by Pierre Baron de Coubertin, the French educationalist and humanist, due to the growing importance of physical education and sports. He provided a solid foundation in internationalism and an organizational mechanism, the International Olympic Committee, which ensured the Games' continuance. Above all, he emphasized the necessity of suitable settings for the staging and operation of Olympic games as agents of both physical and cultural renewal having aesthetic and philosophical meaning. Therefore, he demanded that young architects play an active role in the preparation for these competitions.

His vision of "Modern Olympia", though rather unrealistic of the time, was developed from the first scheme of ancient Olympia which consisted of following elements:

(1) The division of the Olympic Complex into two parts: the semi-sacred precincts, which were in the center of the city for sports, music, the theater and the library; and the profane city as the abode of hoteliers and tradesmen.

(2) The assignment of no important role to the spectators in the transmission of Olympic values.

(3) A pastoral setting for the Olympic city, which need not necessarily be austere and need not exclude joy, but should be an expression of the dignified and lofty purpose of the Games.
Coubertin insisted on athletes and officials being accorded expedient and comfortable accommodation, but on no account a luxurious one. This accommodation was to be in the profane city, comprised of restaurants and accessory buildings of every description, which should be located and slightly hidden away from the 'court of honor' in the outskirts, without direct communication with the center of the city. His idea of temporary housing for athletes, their companies and assistants, was based on practicality, borrowed from the ancient Greek Olympia, which required a contrast to the monumentality of the permanent center of the ancient city.

It was not until the Stockholm Games (1912) that Coubertin's idea of Olympic architecture and the marriage between sports and art were reestablished by the art competitions, involving two disciplines: architecture and town-planning. Though the products of architectural competitions may be regarded as less original and mediocre in general until 1948, the growing internationalization of sports and the standardization of the rules and regulations of Olympic games as by-products of competitions had much impact on stimulating architecture worthy of the Olympic idea and the steadily growing Olympic movement.
Since 1952, architectural planning for the Games has followed the guidelines of the I.O.C. (International Organization Committee) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO), as well as of the Study Group of the UIA (International Union of Architects) and the "International Working Group for the Construction of Sports Premises" (IAKS). They have become the firm backbone for the development of construction techniques, as well as guiding the design and the realization of practical and beautiful buildings with the environment of peace and understanding. The result of this development has delivered another important message of the Olympic idea: "Sports for everybody" (Coubertin), that is, popular and mass sports. Thus, the Olympic achievements in architecture have evoked what has become a world-wide interest expected and imposed by society.

With an ever-increasing number of substantial participants—contestants, officials, reporters, and visitors—the problem of housing them has become serious. As developed by the I.O.C., buildings for accommodation (secondary buildings) and the Olympic Village, Press Village, and Cultural Centers as a part of a housing program have become a major component integrated with sports buildings and the infrastructure of the Olympic City in the "standardized program" of the Olympic Games.
An example which shows the growing importance of the Olympic Village in the Olympic Complex is the questionnaire sent by the IOC and the ISF (the International Sports Federation) to the cities which were applied to stage the Olympic Games. The following questions are among those asked:

(1) All of these facilities should not be too far away with each other and should be within easy reach of the Olympic Village.

(2) What types of Olympic Villages are planned? Where will they be situated?

(Source: "Information for Cities Which Desires to Stage the Olympic Games." Lausanne: CIO 1957, P.7 and 12)

1.2.3. Modern Olympic Villages

From 1896 to 1928, accommodation for athletes, their companions, and assistants was provided by commercial establishments chosen by the participants themselves. In one interesting case in 1912, the USA teams used an ocean-going steamer as a hotel and training facility. There have been a few exceptional cases: simple wooden huts were used in Paris (1900), and a primitive wooden hotel was used in St. Louis (1904). But the expanding scale of participants, especially the increase of spectators, made the problem of accommodation so serious that in 1923 the IOC decided to charge the Organizing Committee of the Games with accommodating the contestants in the future. Hence, the Olympic Village of modern times appeared in Los Angeles for the first time in 1932.
Since the Los Angeles Olympic Games, the development of Olympic Villages has had more comprehensive and far-reaching consequences as large scale housing after the Games. Three phases can be seen in this development (Fig.2)

(1) Suburban colonies consisting of single-story bungalows situated in a charming scenery of an almost idyllic character such as those built in 1932 and 1936.

(2) Housing estates of many-storied buildings such as those built since 1952. It should be noted that Melbourne (1956) with its single storey wooden houses, was the last exception in the trend toward multi-story buildings.

(3) Since 1968, large residential complexes with tower blocks, which achieved the necessary short walk (economy of time) and, above all, the desired communication between accommodation facilities and their subsidiary facilities.

A more detailed description of this development of modern Olympic Villages is shown in Figure (3).

The villages of these large residential complexes were planned in close relation to the other facilities, such as the press center, the cultural center and/or the youth camp, which were located within or next to the Olympic Village. The resultant expanded scale has also necessitated the construction and reconstruction of an urban service infrastructure, so that the planning of an Olympic Village as a center for planning the Olympic sports complex was based on the overall urban structure, and could be only fulfilled on the basis of cultural overall comprehensive town-planning considerations.
<table>
<thead>
<tr>
<th>NO</th>
<th>YEAR</th>
<th>PLACE</th>
<th>NATION</th>
<th>COMPETITORS (total no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1896</td>
<td>Athens</td>
<td>13</td>
<td>295</td>
</tr>
<tr>
<td>2</td>
<td>1900</td>
<td>Paris</td>
<td>21</td>
<td>1077</td>
</tr>
<tr>
<td>3</td>
<td>1904</td>
<td>St.Louis</td>
<td>21</td>
<td>554</td>
</tr>
<tr>
<td>4</td>
<td>1908</td>
<td>Lodon</td>
<td>22</td>
<td>2034</td>
</tr>
<tr>
<td>5</td>
<td>1912</td>
<td>Stockhelm</td>
<td>28</td>
<td>2504</td>
</tr>
<tr>
<td>6</td>
<td>1916</td>
<td>(Berlin)</td>
<td>dropped</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1920</td>
<td>Antwerp</td>
<td>29</td>
<td>2591</td>
</tr>
<tr>
<td>8</td>
<td>1924</td>
<td>Paris</td>
<td>44</td>
<td>3075</td>
</tr>
<tr>
<td>9</td>
<td>1928</td>
<td>Amsterdam</td>
<td>46</td>
<td>2971</td>
</tr>
<tr>
<td>10</td>
<td>1932</td>
<td>Los Angeles</td>
<td>38</td>
<td>1331</td>
</tr>
<tr>
<td>11</td>
<td>1936</td>
<td>Berlin</td>
<td>49</td>
<td>3980</td>
</tr>
<tr>
<td>12</td>
<td>1940</td>
<td>(Tokyo,then Helsinki)</td>
<td>dropped</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>1944</td>
<td>(London)</td>
<td>dropped</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>1948</td>
<td>London</td>
<td>58</td>
<td>4062</td>
</tr>
<tr>
<td>15</td>
<td>1952</td>
<td>Helsinki</td>
<td>69</td>
<td>5867</td>
</tr>
<tr>
<td>16</td>
<td>1956</td>
<td>Melborn</td>
<td>67</td>
<td>3184</td>
</tr>
<tr>
<td>17</td>
<td>1960</td>
<td>Rome</td>
<td>84</td>
<td>5396</td>
</tr>
<tr>
<td>18</td>
<td>1964</td>
<td>Tokyo</td>
<td>94</td>
<td>5586</td>
</tr>
<tr>
<td>19</td>
<td>1968</td>
<td>Mexico</td>
<td>125</td>
<td>6626</td>
</tr>
<tr>
<td>20</td>
<td>1972</td>
<td>Munich</td>
<td>123</td>
<td>10088</td>
</tr>
<tr>
<td>21</td>
<td>1976</td>
<td>Montreal</td>
<td>(sports events; 22)</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>1980</td>
<td>Moscow</td>
<td>(sports events; 21)</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>1984</td>
<td>Los Angeles</td>
<td>132</td>
<td>(sports events; 23)</td>
</tr>
</tbody>
</table>

Figure 2: The History of Olympic Summer Games

(Source: Martin Wimmer, 1976)
### Typological Study of Modern Olympic Villages

<table>
<thead>
<tr>
<th>Year</th>
<th>Type</th>
<th>Scale</th>
<th>Construction</th>
<th>Future Use</th>
<th>Facilities</th>
<th>Note</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1932</td>
<td>Los Angeles</td>
<td>700 units for males only</td>
<td>one storey bungalows made of prefabricated timber section</td>
<td>dismantled after the game</td>
<td>kitchens, dining rooms, open-air stage, Finnish bath-houses</td>
<td>the first actual modern Olympic Village</td>
<td>Baldwin Hill (at the edge of the city)</td>
</tr>
<tr>
<td>1936</td>
<td>Berlin</td>
<td>160 units</td>
<td>tile-roofed bungalows</td>
<td>billet for officers of the German Army</td>
<td></td>
<td>'architectonically excellent to realize the Olympic ideals in the landscape'</td>
<td>In the lake district near Döbereinstern, west of Berlin</td>
</tr>
<tr>
<td>1952</td>
<td>Helsinki</td>
<td>each unit with two to three bedrooms, kitchen, bathroom, and small balcony</td>
<td>cross-ventilation</td>
<td>Residential quarters (multi-family housing)</td>
<td></td>
<td>'the first multi-storey residential buildings'</td>
<td>Espoo</td>
</tr>
<tr>
<td>1956</td>
<td>Melbourne</td>
<td>320 units</td>
<td>cottage housing estate</td>
<td></td>
<td></td>
<td>'the first village for women, but has no architectonic meaning'</td>
<td>Campo Pavioli</td>
</tr>
<tr>
<td>1960</td>
<td>Rome</td>
<td>1,350 units</td>
<td>'ready-to-place concrete column &amp; beam'</td>
<td>public housing (poorly maintained urban residential quarter)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Type</th>
<th>Scale</th>
<th>Construction</th>
<th>Future Use</th>
<th>Facilities</th>
<th>Note</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>Tokyo</td>
<td>5,000 units (36,000)</td>
<td>brick tower</td>
<td>New condominium apt. (urban residential quarter)</td>
<td></td>
<td>'the large central station and the reception building'</td>
<td></td>
</tr>
<tr>
<td>1968</td>
<td>Mexico</td>
<td>1,000 units</td>
<td></td>
<td></td>
<td></td>
<td>decentralized planning with 'Sports Complex'</td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>Munich</td>
<td>2,000 units (stayed) 500 (conventional)</td>
<td>supporting, wind-resistant frame which forms the loggia: supporting beam: room size panel, for 19 storey high rise building</td>
<td></td>
<td></td>
<td>modern planning problems: the first Olympic City of tall buildings including transport facilities and recreation facilities, the combination with the Press Centre, an outpatient department, and a restaurant urban massing with variety in open space</td>
<td>'Harmonie mit Schönheit'</td>
</tr>
<tr>
<td>1976</td>
<td>Montreal</td>
<td>900 housing units (10,000 athletes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980</td>
<td>Moscow</td>
<td>12,000 athletes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The case study of former Olympic Villages shows that planning these Villages involves both qualitative needs and quantitative needs. The qualitative needs, largely based on the ideas of both ancient and modern Olympia, indicate the basic goals and requirements of planning Olympic Villages, while simultaneously responding to their material needs. In addition to those needs, the facts of the historical development of Olympic Villages evoke certain patterns that future Villages should follow. Meanwhile, the socio-economic conditions of the host city or host country has caused building problems which will be explained in section 1.4.
1.3 General Goals and Requirements

1.3.1. Goals

-- to be a symbolic expression of international friendship and harmony: symbolization of the Olympic ideals by means of architectural symbols and technical innovation.

-- to be available for use by the public after the Games, with social services of every description to satisfy cultural requirements.

1.3.2. Requirements

-- to be a dwelling, living and contact center for the contestants, their coaches and attendants, especially to be a comfortable; a convenient dwelling space for those who come from many different cultures.

-- to be provided with sports, training, and recreation facilities, supply and catering installations, and sports and medical equipment, within a short walk or in a convenient easily accessible location.

-- to control the observance of peace or truce among the athletes as stipulated by Olympic game treaties, and to protect the athletes from being attacked by outsiders.

-- to provide a residential environment for a group of unspecified people, both during and after the Games.
-- to ensure an efficient transition from athlete housing to the other future-use functions, such as public housing, hostels and/or dormitories.

1.4. Problems

The problems of planning Olympic Villages, as implied in the goals and requirements, as well as the historical development of Olympic Villages, can be categorized into two categories: conceptual problems and contextual problems. The existence of these problem categories, however, also suggest some solution strategies.

1.4.1. Conceptual Problems

The planning of the Olympic Village has two conflicting aspects - monumentality and practicability vs. symbolicity and convenience - which are the result of the dual purpose of use for both during and after the Games. As a matter of fact, this conflict has existed since the inception of the idea of a "Modern Olympia." With the increasing scale of each successive project and the need to pay back its escalating costs in afteruse, the problems arising from these conflicts has become acute. However neither of these two contradictory concepts should be discarded because of their effects on the socio-economic concern, which is also the national policy
concern, e.g., the display of national power, and the ideal Olympic sprit.

If we regard architectural symbolism as the visual perception of form, and practicability (conveniency) as the behaviorally based performance of function, this conflict tends to receive the old argument over the primacy of form over function and vice versa (which follows which?). Clearly, their interdependence cannot be ignored. Hence, the very complexity which contains two seemingly contradictory concepts is also a clue to solving this problem. According to the discussion about symplcity vs. complexity in post-modern architecture by Robert Venturi (1973), the attitude toward this complexity is relevant to the medium of building (form) and building program (function), which can give not the clarity of meaning but give richness of meaning to the contemporary experience by exhilarating perceptual tension between various forms and functions, disposed in rhythmical orders.

1.4.2. Contextual Problems

The Olympic Village has developed from 700 temporary units of bungalows for 1,331 athletes in Los Angeles (1932) to the complex residential quarters for 12,000 athletes in Moscow (1980). Athlete housing as it should be properly planned, i.e., in close relationship to the other tertiary
facilities, such as the press center and the cultural center, and it originated from the idea of a "Modern Olympia" - "within a short walk," must consider the modern concept of efficiency of organization. Thus, the overall planning for the Olympic Village becomes centralized, rather than decentralized, as in the case of the Rome, Tokyo, and Mexico Games, which led to excessive additional costs for a new systems of city streets, peripheral freeways and organizational efforts.

Within such a centralized planning, the scale of the complex project of the Olympic Village is sharply increased. According to the master plan for the next Olympic Village in Seoul, Korea (1988), its capacity is expected to accommodate 15,000 persons in the athlete village (later to be used as public housing with 3,850 dwelling units), and 7,000 persons in the Reporter's Village (later to be used for 1,850 dwelling units), sited on 621,843 square meters of a suburban area, next to the National Sports Complex.

Therefore, the economic problem of devouring vast sums for the construction of the Olympic City has become serious by straining to the limit of the financial ability of the host city or country to pay for such extravaganzas. In so called developing countries, this problem is of particular importance. The words "gigantism of the Games," spread by the mass media, reflect this concern.
But, the responsibility for this problem should not be blamed on the Games themselves. If we consider the afteruse of Olympic buildings as potential public facilities, while at the same time still in keeping with the underlying idea of "Modern Olympia," e.g., the importance of physical culture and sports for everybody, the concern for costs and benefits should focus on the long-term life-cycle of the buildings, rather than their use during the short time span of the Games and on short-term social-welfare aspects. With a few exceptions, such as the Los Angeles village (1932), which was dismantled after the Games, Berlin's Village (1936), which became military barracks, and the Rome Village, which offered poor living conditions due to poor management, and the Montreal Village, the design of which is said to be of dubious provenance and uncertain utility (such as deep overhangs and exterior side walkways), all past Olympic Villages have become the successful residential quarters as their designers hoped they would, and are occupied today. For example, the Munich Village appears to have overcome the complaints of early residents, and is now regarded by many experts as one of Europe's most successful postwar housing designs for students and the other use groups.

Hence, the costs of the Games should definitely be considered in terms of post-game use. Aside from considerations of post-game utility, the host city or host country should take maximum advantage of the construction or
reconstruction of its urban structure to improve overall quality and to set right the shortcomings of existing patterns and/or existing environmental conditions. Furthermore, the experiences in Tokyo, Mexico and Munich, which proved that only 10% of total costs was for the actual construction of the buildings of Olympic Villages, tends to support the hypothesis that the societal repercussion of an initially high investment of public funds pay off in terms of future social as well as economic benefits for the host city in the long run.

In spite of the above considerations, the immediate costs of the construction of an Olympic Village, while have been sharply escalating over time, are worthy of serious attention in terms of the financial ability and financial risks of the host country. In the case of the Munich Village, the total cost of the construction of an Olympic Village has been estimated to be about $60 million (10% of total costs of $600 million). Furthermore, considering opportunity cost, it is evident that the priority of investment would be placed on the permanent future demand that can be accurately expected. That is, the demand for sports facilities varies, because of the changing popularity of sports, while the demand for housing is relatively constant.

There have been a few proposals dealing with such large, extravagant, and increasingly expensive building efforts. One
proposal separates the kinds of Olympic sports games into distinct clans of events, and suggests playing each category in a different country. But, if this proposal is accepted, the Olympic Games will be converted into a world championship event. The other proposal is to hold all future Olympic Games in a fixed location in Greece. But this proposal would not retain any of the lasting benefits, discussed and functioned earlier such as "sports for everybody," architectural and technical development, and so on.

In addition to the above, the problem of a limited time schedule for the building process must be considered. The usual development of an Olympic Sports Complex project requires one year for design development (competition), plus one more year for the organizers to check the expediency and suitability of all the proposed facilities. If we consider that the host country is selected six years before the forthcoming Games, then the four years for the construction work proper becomes too short a time. With respect to the cost problem, the time element causes problems of management, control and organization of project delivery. In the case of the Montreal Olympiad this matter became quite clear.

In 1972, Montreal City and its able and energetic mayor, Jean Drapeau, were committed to staging a "modest, self-financing Games," especially after presiding over
several large building projects including Montreal's Metro and Expo 67. The budget was $c.310 million ($c.250 million for construction, $c.60 million for organization), half of the cost of the Munich Games. This was supposed to be a sum that could easily be recovered from anticipated revenues - income from lotteries, television rights, ticket sales, posters, coins and special endorsements. But the actual final cost (direct cost: $1.4 billion) was more than twice as much as that of the Munich Games ($850 million) and caused a deficit of one billion dollars; furthermore, construction could not be completed in time for the games.

Although project implementation began slowly, and inflation escalated sharply, these played only a small part in the economic failure of the Montreal case. Other factors including too complex architectural designs, lax project management and the opportunism of only indulging in maximizing the manufacturers and contractors' investment, appeared to be the crucial reasons for this economic failure. Mayor Drapeau thus succeeded in political leadership, but failed to provide the organizational leadership and project control required for such a large and complex project. (Auf der Maur, 1976)
In contrast to the development process in Montreal, in the case of the Munich Village, some private developers, semi-public developers and the student unions provided the capital for the buildings in the Village. Their interests in the after-use of the buildings made the first plan of the Olympic Village replanned. That is, capitalists wanted to make adjustments not only in the detail designing but also in the overall organization. For example, all the buildings were planned to be built in precast concrete, but in the case of the woman's village, the buildings were built in cast-in-place concrete. Especially, owing to the developer's interest in selling off more buildings as apartments, or developing rent housing after the Games a number of lowrise apartments had to be placed within the snaking fabric of the first layout, and the slab blocks on the east of the site were raised from eight stories to eighteen stories. (Middleton, 1972)

The reasons for these changes were the disagreement of all the participants on the plan of the Olympic Village and the incorrect cost estimation in the development process—particularly the change in construction methods due to the short planning and preparation time and difficulty in maintaining a large number of suppliers. This case exemplifies the trouble in delivering the project successfully under the pressure of deadlines and cost.
Despite the problems with the Olympic Village, the large-scale project of sports complex in Munich, which was seemingly superfluous and gigantic, was successfully finished on schedule. This was due to the founding of the Olympic Building Authority, commissioned by the Organization Committee, which performed functions similar to those of the Construction Management approach in a building process. That is to say, this group coordinated and controlled the selected parties: the public agencies, architects & engineers, consulting firms, material vendors, manufactures, and users. Moreover, this group has set up a macro net-work plan which would coordinate individual micro net-work plans for smaller construction tasks. Those plans were based upon the overall Olympic construction programming, time scheduling, budgeting, estimating, and financing which are important in the building process. (Johannes Galandi, )
2. APPROACH

2.1 Patterns
   2.1.1 High-Rise or Low-Rise
   2.1.2 Construction
   2.1.3 Secondary Problems

2.2 Concept
   2.2.1 Flexibility

2.3 Context
   2.3.1 Fast-Track
   2.3.2 Systems Approach
2.1 Patterns

2.1.1 High-rise or Low-rise

The overview of past Olympic Villages shows that the planning of an Olympic village has an intimate relationship to the overall planning of a Sports Complex. There were largely two types of approach in the overall planning which have the following implications:

1) Centralized planning is more economical because of easy management control and organization.

2) Decentralized planning is more costly because of extending higher land prices of sites to be acquired and the additional costs for the transportation and service infra-structure systems.

Although decentralized planning is more costly, it can be utilized for potential or needed urban redevelopment on an overall city scale. However, if we consider that the basic Olympic ideas—"within a short walk" and "sports for everybody"—as well as the cost, it is evident that Sports Complexes and Olympic Villages should be located together within or near the core of the metropolitan area with its high density of population and variety of urban contacts. In addition to the need of such a centralized planning, the increasing scale which is already exposed in the program for the next Seoul Olympic Village (Fig. 4), predicts the pressure of cost on the developments of future Olympic Villages.
<table>
<thead>
<tr>
<th>Section</th>
<th>Function</th>
<th>Net Area</th>
<th>Public Area</th>
<th>Gross Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESIDENTIAL</td>
<td>Residential</td>
<td>514,404</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>Houses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dining Hall</td>
<td></td>
<td>6,000</td>
<td>1,200</td>
<td>7,200</td>
</tr>
<tr>
<td>Kitchen</td>
<td></td>
<td>3,170</td>
<td>630</td>
<td>3,800</td>
</tr>
<tr>
<td>* Total Area</td>
<td></td>
<td></td>
<td></td>
<td>11,000</td>
</tr>
<tr>
<td>Public Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reception Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreation Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming Pool</td>
<td></td>
<td>2,370</td>
<td>590</td>
<td>2,960</td>
</tr>
<tr>
<td>Recreation</td>
<td></td>
<td>2,050</td>
<td>510</td>
<td>2,560</td>
</tr>
<tr>
<td>Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td></td>
<td>200</td>
<td>60</td>
<td>260</td>
</tr>
<tr>
<td>Stores</td>
<td></td>
<td>1,470</td>
<td>440</td>
<td>1,910</td>
</tr>
<tr>
<td>Services</td>
<td></td>
<td>370</td>
<td>120</td>
<td>510</td>
</tr>
<tr>
<td>* Total Area</td>
<td></td>
<td></td>
<td></td>
<td>3,080</td>
</tr>
<tr>
<td>Public Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** Total Area of Athletes' Village 538,044

(Fig. 4) Source: International Architecture
of Competition for '88 Seoul Olympic
Therefore, within a centralized macro-net work plan for Sports Complex, the micro-network plan for the Olympic Village and its tertiary facilities is likely to require highrise buildings because of following reasons:

1) The low ground coverage tends to reduce the high costs of new land acquisition, and fill the need to conserve valuable land for green space in the environment of the Olympic Village.

2) The short distances between housing and its facilities confirm to the idea of Modern Olympia, e.g. sports for everybody within a short walk.

3) The ground floor area of each high-rise unit can be devoted to administrative or service facilities such as reception center, convenience facilities, recreation center, shopping center, and so on. Hence, dwellers living on upper floors can feel safety against attacks by outsiders.

4) Concentration produces conveniences and ease of social contacts which are the essence of all communities, whether these are for athletes or permanent city dwellers.

The overview of the typologies in past Olympic Villages since the Mexico Village(1968), provides evidence that highrise buildings have been more frequently used than low-rise buildings or row houses. These typologies are shown below where high-rise buildings have been defined as multi-unit structures in which primary reliance is on elevators for access to dwelling units.

1) Row houses (terrace houses and patio houses) and walk-up apartment: in some parts of the Munich Village- 2 to 4 stories.

2) Elevator apartments
   a) Slabs: Munich village- 19 to 20 stories
      Montreal Village- 21 to 23 stories
      Moscow Village- 16 stories
b) Towers: Mexico Village- 10 stories

As can be seen in the program for the next Seoul Olympic Village (Fig.3), the scale of an Olympic Village and its tertiary buildings has been sharply expanded. This was dealt with in the preceding section on Contextural Problems. Since land must be purchased to accommodate many or a great number of participants and facilities, and land values are usually high, the use of high-rise buildings in the future to house the high number of expected participants calls for concentrated facilities near the core of the metropolitan area of the Olympic City in the future.

2.1.2 Construction

Saving land by the use of high-rise construction means both direct savings in money and indirect savings in benefits of various kinds as explained in sub-section 2.1.1 (High-Rise or Low-Rise). However, if high-rise construction is allowed to increase the building cost unduly, savings or benefits from intensive land use will be reduced or lost entirely. We need to determine where the real cost/benefit differentials between high-rise and low-rise construction occur, so that we can minimize those factors which tend to add cost, and capitalize on cost saving factors, thereby achieving appropriate economies for the selected pattern - in this case high-rise construction.
A study made at the University of Illinois by the architectural & planning firm of Richardson, Severns, Scheeler & Associates (1963) shows that equivalent buildings designed as low-rise and alternatively high-rise tend to differ in cost by the added amount spent in the high-rise for elevators and the area they occupy (1). The amount of added cost for the high-rise unit is then compared with the related land area. Since elevators are basic to high-rise residential buildings, the number of elevators or type of service cannot be readily changed. (Fig. 5) Hence, it is crucial to develop efficiencies in dwelling unit groupings and corridor relationships which will reduce total floor area and tend to offset some of the area increases which are unavoidable in the high-rise building. This can only be achieved by careful design and programming.

For maximum economy and to achieve cumulative savings, the design of a typical residence floor—especially in a
A high-rise unit should include the following factors:

1) Relate the typical floor plan to bay spacings of an appropriate structural system which lends itself to the kind of space arrangement desired.

2) Be consistent in the use of the structural system by regularity of bay spacings, similar loadings, and uniformity of structural elements.

3) Locate openings for elevators, stairs, risers and ducts to relate to the structure with a minimum of disturbance.

4) Determine mechanical requirements early so that distribution systems may be economically related to the structure and the building design.

5) Use of a limited number of materials to serve similar functions in a similar manner.

6) Select basic building components carefully and then use them generally so that a minimum number of types of windows, doors, plumbing fixtures, light fixtures, etc can be used. (source: University Facility Research Center, 1963)

In order to realize these factors, in the building context having capacity for the development of prefabrication, it would be desirable to use industrialized construction techniques and prefabricated components (assemblies) which have been developed to increase the compatibility between structure and other subsystems with the use of minimum number of subsystems, components, and their repetitive use. If this is so, the design of high-rise buildings can take advantage of the actual cost benefit of 'industrialization' (3), in terms of time, efficiency and cost.
The measure of 'industrialization' is often given as the percentage of work done off-site in the factory, while general construction costs are significantly affected by regional and local factors. Hence, Bernard D. Stollman estimates a savings of 11\% by comparing conventional high-rise housing with industrialized housing under favorable conditions. These savings by the actual cost benefit of 'industrialization' are the numbers of:

\begin{itemize}
\item [+15\%] Lower factory wage rates taking into account increasing efficiency.
\item [+3.75\%] Reduced construction cycle.
\item [-7.5\%] Extra cost of amortizing a factory over field overhead
\item [+11.0\%]
\end{itemize}

The overview of the construction types of Olympic Village buildings since 1932 also shows the use of industrialized building methods for the construction of high-rise buildings, such as panel and slab components in Munich and Moscow, as well as lift slab construction in Montreal. However, each host country was not willing to use the newly developed building technologies and materials used in the construction of sports facilities. That is, the host countries built the Villages as standard public housing for post use, so that the Villages could be an income source by potential renting and sales. Thus, they tried to evade all
possible risks which would result from the misuse of new technology by the existing skills and practices of the conventional building industry. Especially, in a so-called developing countries which have abundant unskilled labor in conventional construction, the extensive use of new technologies or the use of a minimum on-site labor needs careful consideration of the employment ratio of the construction worker (4) and the balance of payments (5) related to imported services and materials. These kinds of economic considerations are beyond the scope of this study, as the most highly industrialization of the building sector would require the total reorganization of the building industry into a coordinated, vertical production-shipping-assembly format of organization, with a strong relationship to other fields of industry in a different economic condition of each country.

Therefore, the cost implication on construction raises two critical points in terms of high-rise types to be developed in the Olympic Village:

1) The careful study of the spaces of the units, as well as access, and service, which should have a relatively high importance in design.

2) Construction may well use industrialized building techniques if these are developed in a gradual process, and which can be combined with the use of conventional building methods.
2.1.3 Secondary Problems

The application of industrialized methods to building may also have some disadvantages. That is, the repetitive use of small numbers of elements may lead to excessive monotony. We can observe this monotony in the Moscow and Rome villages. Though there is no information on the after-use of the Moscow Village, the Rome Village failed to be a desirable living place. In contrast to the monotony of the Moscow and Rome Villages, the variety in the design of the Munich Village brought about a more liveable housing environment. Buildings of various shapes are clustered in a compact manner, and the open spaces harmonize with the green spaces. Besides, each dwelling unit has varying room types and arrangements. Each unit can be accessed by galleries or a double loaded corridor, and has a terrace or balcony.

Not only monotony but also organizational changes (6) and less freedom of choice (7) are disadvantages created by the misuse of industrialized methods. In this situation, the following considerations are crucial to prevent these disadvantages, in the use of industrialized building techniques:

(1) In order to avoid monotony, design should be a process providing variety, which can give accent in repetition in design with the use of a small number of building elements.
(2) The design process should evaluate many alternatives of space types and their arrangement in terms of cost.

However, in order to operate such a design process, the process should be shared with all related participants selected by a program. Therefore the study in the next chapter will deal with a contextual approach which may establish the appropriate framework in which a design process may function well, as well as a conceptual approach which may suggest design goals which the design process should finally yield.
2.2 Concept

2.2.1 Flexibility

Our experiences in the variety of meaning are accumulated on our value systems through the perceptual receptors which are faced with information from the real world. This information is delivered to real users by the forms and functions of buildings at a specific point of time and/or during a certain period of experiencing an environment over time. And, our value system makes a decision on whether the sense of informations will be shifted to the memory images that we value. Subsequently, our behaviour is then strongly affected by these images. (Fig.6)

(Fig. 6 : Roger M. Downs, Geographic Space Perception, Progress in Geography, Edward Arnold Publishers Ltd., London, 1970, p.85)
If the above environmental perception of a building is appropriate enough to affect users' behaviour, the building would have real symbolic meaning. In other words, building may be seen as important artifacts that satisfy their users, because they symbolize something that the users value.

An important question about environmental perception would be how the everyday user perceives simplicity versus complexity in modern architecture and urban design. Architectural theory of the 1920s to the 1940s, and especially the concepts of the international style, favored simplicity of form and highly regular geometric configurations. But how do users perceive such forms? First, the vast majority of users do not perceive subtlety of geometric configuration, especially when it is only noticeable in plan and cannot be appreciated without the most difficult of intellectual exercises. Nor do people prefer the stark or brutal simplicity of many modern buildings. Second, curiosity, play, exploratory behaviour, and human development are stimulated by variety and complexity in the environment. Passive exposure to environments can actually be detrimental, and redundancy can lead to arrested development, while variety and complexity lead to an active commerce, exploration and development. (Gary T. Moore, 1979)
In order to create an environment having variety and complexity, physical objects for a setting of the environment may well have flexibility which can be frequently defined by other basic terms:

(1) variability: "apt to change or vary; to make different from one another".

This is the intrinsic ability to make different or vary while otherwise maintaining stability.

(2) adaptability: "to make suitable by changing; to adjust to new circumstances".

Adaptability emphases the maintenance of stability through the exercising of an inherent ability to adjust to changes in external conditions. (Oxmen, 1976)

2.3 Context

The conceptual problem and contextual problem described in section 1.4, are to a large extend due to the increasing scale of the projects. The spread of the Olympic idea and the propagation of competitive sports in all parts of the world will probably lead to a further increase in the number of participants, officials, reporters and spectators at the Olympic Games. In addition to a few proposals for changing the operation of the Games, there has also been the demand for moderation in the scale of the Games by the countries
concerned with Olympic Games. Not only the spiritual idea of the Olympic Games, but also the present system, under which the federations involved in the Games share in the revenues from their events, work against moderation. Hence, a strategy should be provided, not for avoiding the problems related to the increasing scale, but for accommodating and solving the problems involved in large scale project delivery.

2.3.1 Fast Track

In brief, most contextual problems are due to the pressure of deadlines and cost tied to large scale project delivery. Here, the need for searching for an appropriate building process including programming, planning and execution, appears, in order to shorten building time and to reduce building costs. In the traditional building process, design and construction phases of work are usually arranged sequentially end to end. In a very large scale projects, this kind of process easily leads to wasted time and money, especially because of different interests of the many people involved and because of the increased project complexity.

In contrast to conventional linear design and construction processes, the fast-track process overlaps the phases of the building delivery process (Fig.7), and thus reduces building delivery time. Depending on the degree of fast-tracking, design and construction time may be
reduced as much as 25 to 50 percent. In addition, this approach has the following advantages over conventional process:

-- It reduces the impact of inflation by completing the building sooner.

-- It keeps design options open longer.

-- It can save costs because of shorter periods of interim financing during construction, and higher income or cash flow, due to earlier occupancy.

(Fig.7)

If fast-track is to work successfully, the following considerations should be kept in mind:

1) Because of early commitment to decisions not only by the designer but also by the owner, decisions become irrevocable, even the bad ones. Hence, careful construction scheduling and planning, coordination and constant communication with all the team members are essential for the A/E (Architect and Engineer)'s work and the construction to proceed in a continuous and logical sequence.

Here, it is desirable to use the services of construction management, which has the expert knowledge of estimating the accurate cost of multibidding, developing scheduling network diagrams or the critical path method, forecasting and managing cash flow,
helping the project team make fast decisions with much updated information, and so on. (Fig. 8)

2) Deferring as many sensitive decisions as possible by fast-tracking reduces the time interval between design and construction, and limits potential design obsolescence; both technical and social.

Therefore, one of the first decisions should be to divide the total building procedure into a set of subtasks. While these decisions are being made, the following points should be considered:
1) The spaghetti effect (A. van Randen 1976) (Fig. 9), due to complicated and unexpected interactions between the various decisions taken in the building process should be limited, so that earlier decisions would not have much influence on later decisions.

2) Local approving agencies must issue building permits to start construction without having a complete set of drawings and specifications to review.

3) Local trade jurisdictions, subcontractor availability and workload, dollar value of the contract and bonding capacity of probable constructors, and local construction practices are should be also considered.

---

**Fig. 9: Spaghetti Effect:**

If someone pulls on the end of one piece of spaghetti, he gets movement at the most unexpected places on the plate. Once he starts noticing it, he can hardly stop.

Source: A. van Randen, 1976

---

2.3.2. The Systems Approach

Because of multibidding and the early commitment to decisions in the fast tracking approach, the owner cannot estimate the final total cost of the project. This means that the financial risk of the owner becomes greater. One way to
reduce risk is to employ systems building; pre-engineered manufactured building components can be costed out far more accurately than can the site-built portions of a building. Therefore, a detailed construction budget is established for the related groups of subsystems and the design is carefully scrutinized as it considers and evaluates other possible combinations or packages of subsystems. In addition, existing building systems allow for a short design phase, as well as for early bidding and delivery time. On some systems-built projects as much as 75 percent of the price is under contract early in the design phase, i.e., a year sooner than is possible when using conventional construction methods. And, a large portion (50 percent) of a building systems project can be bid by manufacturers very early, i.e., the first month into the design process.

Furthermore, the correct information about the cost and performance of subsystems and/or their combinations facilitates value engineering and life-cycle cost analysis. In life-cycle cost analysis, we can compare subsystems and/or their combinations by predicting the total cost of owning a building throughout its assumed life. This comparison can be done by estimating total costs or a building's present worth, which consider maintenance, operation, replacement, and so on. The fast tracking approach in a building process offers a great advantage for systems which can be defined as the assemblage of the subsystems or components by some regular
interaction or interdependence. Therefore the fast tracking approach can be conceived as one part of the systems approach to building.

While the conventional approach to building is composed of sequential steps such as programming, design, bidding, contracting, and execution, the systems approach allows some steps to be arranged in a parallel or even in reversed order, which is also appropriate for the fast tracking approach. Therefore, the systems approach has the following advantages over the conventional process:

(1) Predictability of the final building result of design and construction is more accurate.

(2) The development of alternatives can be achieved with low cost.

(3) The feedback process exerts influence on the decision at the time of concern.
3. FLEXIBLE SYSTEMS

3.1. Introduction

3.2. Analogies related to Industrialized Building Technology
   3.2.1. Clocklike Systems
   3.2.2. Cloudlike Systems

3.3. Flexible System Analogies
   3.3.1. Wine-Bin Analogy
   3.3.2. Bookcase Analogy
   3.3.3. Seed Analogy
   3.3.4. Chess Analogy
3.1. Introduction

The discussion of the preceding chapter shows that a systems approach is appropriate for obtaining the design flexibility in Olympic Villages. The systems approach has been developed for prefabricated buildings (building systems) by means of rationalization(8). This chapter intends to show which types of systems are more appropriate for obtaining choice and change of function and form in buildings in general.

Some common types of systems are categorized by analogies, so that their meanings in generating and operating systems can be compared and analyzed. First, the ideas connected with the concept of industrialized building technology are dealt with by the analogies of "clocks" and "clouds". The second set of ideas, concerned with flexibility, are characterized by analogies to "wine-bins", "bookcases", "seeds" and "chess sets".

Though the analogies may be symbolic, the concepts would revealed by them, provide a good paradigm for developing a systems approach for flexibility in building systems.

"Analogies are convenient only to the extent that they are helpful in establishing a general context which otherwise would be difficult to express in a few words without distorting the message to be conveyed." (E. Dluhosch, 1973)
3.2. Analogies related to Industrialized Building Technologies

Karl Popper, in writing about systems, distinguishes between "clocklike" systems - which function like clockwork, producing predictable, predetermined final products - and "cloudlike" systems - which behave like a cluster of gnats or a school of fish, predictable only in a general sense, but not in terms of individual elements.

3.2.1. Clocklike Systems

Buckminster Fuller's 1927 Dynamaxion 1 House (Fig. 10), developed along the lines of his previous work - the Stockade building system, a ten-deck house design - which was designed as a self-contained universal unit in which the environment was totally controlled by innovative technology and new materials invented for this project. His whole attitude was founded on technical imperatives with the idea - "The individual can take initiatives without anybody's permission" (Fuller 1927). The theme of his work was that the home as a machine can be fully supplied by mass factory production. But, his idea only ended in the realization of the Wichita experiment, and had little impact on the existing housing industry. The cause was the lack of full consideration of local conditions, conventional methods of building, and the traditional patterns of family life.
Predictability, the basis of his approach, was accurate only in the technology and the science areas. However, such an approach could not have total control over unspecified uses and needs, and did not take into consideration real needs of the participants in the building process.

Fig.10
Elevation and Plan of MINIMUM Dymaxion Home

This kind of an approach can be compared to a clocklike system which functions like clockwork, producing predetermined final results, as exemplified by American prefabricated housing programs, such as the Lustron House in 1946. The Lustron company, created by the engineer and inventor Carl Strandlund, built a practically all-steel house
with welded frame components, interlocking porcelain enameled panels for inside and outside walls, complete window and door assemblies, etc. But the Lustron production line was closed only four years after it was set up, having commenced production in 1949. The attempt by Lustron to create an industrialized vernacular package house—a so-called "Ultramodern" house—was mirrored in post-1945 Britain, where the implications of such an approach were being worked out in terms of modular coordination, the use of grids, and dimensionally related components at Hertfordshire (9), by Arcon and later by the Modular Society (10), though their works may not belong to "Clocklike" systems.

At that time, it may be concluded that Lustron's failure was due to the lack of distribution network and financial mechanism such as in automobile industry. But, the more important cause was that the production of a "closed" housing system, which was produced by concentrating mainly on technology, could not cope with the variety of housing demands in a disaggregated cyclical market. In other words, packaged components produced in a single expensive manufacturing plant and unmodifiable at the site did not reach the required economy of scale for mass production because of the failure of meeting user requirements for variety and diversity.
The failures of these systems are basically due to the mis-interpretation of problems in confronting a highly complex society in which the planning of human shelter must satisfy man's economic, social, and psychological needs. According to Rittel and Webber (1973), there is no definite answer or solution for "wicked" problems, e.g. complex and intractable societal problems that planners deal with, in contrast to the "tame" problems which scientists and engineers handle with clear goals and directions, whether or not these problems have been solved. In other words, societal problems related to building tend to be more and more complex than pure engineering problems, so that a single view leading to a predetermined result is not enough to accommodate the large amount of information which is needed to formulate and solve problems in planning which have both technical and socio/cultural implications.

Therefore, it is evident that the planning approach for industrialized building systems should start from a definition of the "wicked" societal problems. As stated above, this approach cannot have pure true-false solutions as formulated in the hard sciences. But the approach for "wicked" problems can provide a holistic framework within which many alternative solutions can be given to different user groups. That is, in such a holistic framework, each individual can make his own decisions using his own values, which are controlled and harmonized with the other's
decisions. Thus, a desirable systems approach for industrialized residential buildings may well be conceived as for the cloudlike systems which can be predictable in a general sense, but not in terms of individual elements which may include the clocklike systems. Therefore, such "Cloudlike" systems are discussed in the following section.

3.2.2. Cloudlike Systems

In 1914, Le Corbusier introduced the Domino project (Fig. 11), which was a scheme for low-cost housing production. His approach was based on the separation of secondary industrial building components from the primary other structural framework. Wall elements and infill elements thus provided the architects and theoretically the user with the possibility to adjust these products and materials to meet their changing needs. These components or subsystems may thus be inter-related and organized hierarchically to be capable of exchanging these secondary elements with their environment, while keeping constantly the primary structure during the life of the building. The final product of this kind of system is therefore predictable in a general sense, but not in terms of individual elements.
The system resulting from this approach can be regarded both as an hierarchic system and as an open system which can be defined as follows:

(1) Simon (1962), in his paper on hierarchy as a form of organization for complex structures, has defined the hierarchic system as a system that is composed of inter-related subsystems, each of the latter being, in turn, hierarchic in structure until we reach some lowest level of elementary sub-system.

(2) Von Bertalanffy (1968) has defined an open system as a system in exchange of matter with its environment, presenting import and export, building up and breaking down of its material components.

The notion of a hierarchical open system has been advocated by many architects and groups in the mid twentieth century. Among them, N.J.Habraken developed his theory and design method based on "Support and Detachable Units", and C. Alexander in his "Pattern Language". The Archigram group (11) and the Japanese Metabolists (12) were among those who planned for variety and change with the notion of a hierarchical open system on the city scale, though some of
their works were, eventually realized as "clocklike" systems.

Hierarchical open systems can respond to the needs of real users in housing by the nature of the indeterminacy of final building results and the hierarchical separation of building elements. Salient features of these kinds of flexible systems are further explained by the analogies of the "wine-bin", the "bookcase", the "seed" and the "chess set".
3.3. Flexible System Analogies

3.3.1. Wine-Bin Analogy

The idea of the Domino project was further developed in the Marseilles Block in 1947 (Fig.12), which was supposed to be taken down as the fixed frame and infills. Both are analogous to the wine bin and wine bottles, having fixed shape and size, but containing wine of every variety. In other words, this type of system has fixed bays and spans which divide spaces repetitively, thereby accommodating only a few differentiated groups of functions. But the users can only achieve such flexibility by using different arrangements of furniture as in any kind of apartment, and some movable partition walls in a cell. These systems are usually either
composed of the open frame as a support and the rigid boxes as infills, or the rigid box as self-supporting units and the panels as infills. This analogy can be extended to the idea of capsule dwellings.

(1) In 1964, Warren Chalk, one of the Archigram Group, devised a capsule dwelling, with wedge-shaped units sitting in a tower, which was to be the preferred type in a "plug-in" city. It consisted of a set of components which were capable total inter-changeability to provide for changing needs and technical obsolescence. The main parts of a capsule dwelling were made of pressed metal and/or GRP (Glassfiber Reinforced Polyster), though later the possibility of using pressed paper started to interest the Group.

(2) The idea of the capsule dwelling was explored by Kisho Kurokawa, one of the Japanese Metabolists, in 1963. It was finally realized in several locations in Japan in the early 1970s.

(3) The wine-bin analogy was applied to the Welton Becket Contemporary Hotel (Fig. 13) at Disney World, using prefabricated steel room modules to speed completion and to build in the possibility of rapid room refurbishing in the future. That is, the modules were held by huge steel A-frames, and completely equipped with all what a hotel room must contain.

(Fig. 13) Contemporary Resort Hotel, Walt Disney World, Orlando, Florida. 14-storey A-Frame structure with rooms terraced up both sides to form a vast interior lobby concourse through which a monorail passes. The end walls are glass sheeted. The 1050 room units were pre-assembled steel construction.
Architects: Welton Becket and Associates)
In terms of variety and change, the future use of the "wine-bin" buildings is predetermined by the fixed frame, which ultimately dictates a few generalized living patterns determined by high technology. That is, such an approach for "wine-bin" systems cannot accommodate plural users of multi-dwelling units, but can only accommodate one type of users which is not a real open society. Furthermore, the use of capsules may be considered as no more than symbolic formalism, since they could not be interchanged and were actually no more transient than the supporting structure. Given these deficiencies in supposedly flexible systems the following considerations should be kept into mind when we develop flexible systems are developed.

1. The use of high technology should enable users to operate the flexibility of a building directly as much as possible.

2. The separation of building elements into supports and infills should be based on flexibility, both between rooms and between dwelling units.

3. Building with box-type units can shorten assembly time on site, be produced under controlled factory conditions, and reduce labor costs per housing unit. However, box-type construction puts certain limits on architectural design and use in terms of flexibility, because of allowable shipping widths and many other constraints. The above discussion does not cover the full range of possible examples, but is meant to provide a basic conceptual framework for the following discussion.
3.3.2. Bookcase Analogy

The origin of this analogy can be found in the mid 1930's when Erik Friberger designed a block of flats in Gothenburg, Sweden. The system was composed of so-called support and infill units. Differing from the support and infills in the wine-bin analogy, all the components of 'bookcase' units can be changed with the exception of the plumbing connections. Townland (Fig. 14), one of the competitors in Operation Breakthrough(13) also devised a similar kind of system, which provides variety and adaptability in conventional multi-family housing. Within the frame, the system provides flexible space for various housing types. However, the original scheme could not be fully realized in the implementation by HUD (Federal Housing Administration), because of the lack of much broader and long-term governmental commitment. Besides, the other obstacles were user reluctance, the application of Townland to low income housing and the location of project.

(Fig.14 Townland's bookcase analogy went beyond the wine-bin in offering flexibility and diversity to the users of the housing)
The bookcase analogy can accommodate more undetermined multi-functions than does the wine-bin analogy. In order to do that, it requires variable bays and spans to accommodate different shapes and sizes. In common systems applying this bookcase analogy, the panels are agglomerated by the skeleton frame structures --- the wall-supported floor (bearing wall structure) and the column-supported floor (post column structure) ---, or the framed boxes or open boxes are stacked as self supported boxes. But, the application of box system to these cases has restriction in flexibility because of allowable shipping widths.

The design method suggested by Habraken has the same theoretical goal for the building design process as the bookcase analogy. But the fixed dimensions and locations of categorized spaces, determined from the zone and margin analysis, lead to a limitation of the various space configurations in actual practice. For example, there is the question of how this method can arrange spaces whose shapes are not rectangular or square, and for complex tower forms. Furthermore, this method cannot handle situations in which the functions of the spaces are the same in different horizontal zones and/or different vertical zones. Furthermore, though the decisions on zones can be well made by a full consideration of the user's requirements, they also should be based on the optimal distribution characteristics of all the involved subsystems.
It is evident that the examples of bookcase system discussed above are quite flexible compared with the wine-bin analogy. However, excessive variability often increases building costs. Generally, larger spans are necessary, and demountable walls, operating walls, screens, folding doors, and etc. are usually more expensive than fixed ones. These higher costs must be weighed against the savings incurred by a more efficient infrastructure through higher densities - which often leads to the building of high-rise buildings with additional low-rise buildings, particularly on the site having high land price, compared to other housing types of equivalent quality.

3.3.3. Seed Analogy

The Danish architects, Peter Stephensen and Oruno et al., visualize expandable and shrinkable houses as seeds; just as a seed does not have the form of the full-grown plant, minimal housing unit does not have the same form as a completed building. Habraken's organic analogy which considers the urban fabric as tissues and cells can also be included this analogy. The seed, having space for the minimum requirements of living and sleeping, can grow by both temporary and permanent additions.
This idea of seed analogy is originally based on the concept of sites and services in which the user is only furnished a building lot with services brought to the site. With the varying degrees of user participation (building jobs are transferred use after the first builders' work, different ways of implementing industrialized housing, e.g., the evolving house (14) and the core house (15) belong to this analogy. However, solutions based on this analogy may create problems of implementation in housing projects, due to unspecified responsibility of the participants, and the low levels of user education resulting in poor organization and skills. Though, the main reason for the use of "sites and services" is economical to provide basic services at lowest possible cost, the result of "seed growth" due to economic growth, can provide the user with much flexibility in particular variety. Hence, the careful consideration of the practical process to distribute and operate subsystems should be taken.

The later Archigram and Metabolist movement took steps toward a metamorphosis concerned with changes in the physical form and structure of cities that would respond to the needs of a dynamic society. The examples of the Gasket Homes designed by Ron Herron and Warren Chalk (1965), the City in the Sky by Isozaki, the Helix City by Kurokawa, and Marina City by Kikutake, show that all these groups and individuals
tried to provide more variety, change, and scope for expansion in a flexible megastructure(16) for undetermined needs. Unfortunately, none of these examples were more than conceptual approximations. The formal idea of Megastructures was based more on architectural phantasies about technology, rather than on the technological realities of the building industry and the ability of clients to realize such utopias or something along these lines.

3.3.4. Chess Analogy

This analogy implies a type of system which consists of a kit of parts, similar to chessmen and a chess board, and a set of rules, allowing different moves to achieve different outcomes of the game. The kit of parts is not a specific system or a package of subsystems, but may be composed of many different systems and/or subsystems which are interchangeable and compatible. The set of rules is a set of performance specifications which indicate the function and properties of the kit-of-parts, and modular coordination may be compared to the chessboard on which all the players make their moves in the game--manufacturer, contractor, client and architect--as players.
Typical examples of these type of systems are the Techbuilt house (1953) by Karl Coch (17) (Fig. 15), the Marburger University Building system in Germany (1956) (Fig. 16), the CLASP (Consortium of the Local Authorities Special Programme, 1957) (Fig. 17), and the SCSD (School Construction Systems Development, 1961) (Fig. 18). The CLASP system was developed on the basis of the Hertfordshire program, thereby setting up an elaborate system of cooperation and coordination such as the working team, development groups, development of a dimensional coordination system and serial contracting. The success of the CLASP program of prefabricated schools by following contractual procedures on the basis of a serial production, affected the development of the SCSD program, which represents a successful flexible system. Another example is the Marburg system which also applied the chess analogy.

In the Marburg system, the pre designed catalog components - structural (load-bearing) elements and non-structural (skin, infill, partitions, etc.) are coordinated on a tartan grid which is particularly useful for indicating clear convention on possible junction types (Fig. 19). Meanwhile, in the SCSD system, six integrated subsystems - structure, roof, heating/ventilating/air conditioning, lighting/ceiling, partitions (fixed, movable, and operable), and cabinets and fixed laboratory furniture lockers - are integrated.
(Fig. 15: Techbuilt House, Carl Koch, 1953
top; Exterior View
left; Exploded Perspective)

(Fig. 16 Section through Coordinated Structure/Service System in Marburg Example)
(Fig. 17 Isometric projection of typical building showing the relationship between the various components and the module lines, both vertical and horizontal)

(Fig. 18 Diagram of the SCSD system, illustrating all the major components)
The subsystems of the SCSD system have high compatibility because of the use of performance standards as part of the rule system. The structural subsystems are integrated on a 5 foot by 5 foot horizontal and a 2 foot vertical module or multiples of these modules. The partitions and the other interior subsystems are tightly integrated with the structure on a horizontal 4 inch by 4 inch module (Fig. 20).
The SCSD system and the Marburg system result in providing spatial variety, the possibility of immediate change of spaces and functions, long-range changeability, vertical and horizontal expansion, and the feasibility of realizing various building configurations for different contexts and sites. Therefore, the waves generated by the $680,000 investment in SCSD are still radiating from the original projects, and here effectively raised school design standards, cut costs, and accelerated construction schedules in many parts of the U.S. and Canada. Though these systems were developed for educational facilities having similar requirements, they could be used as precedents to develop similar tactics for generating and operating other flexible systems, thereby reducing possible constraints to provide much flexibility and solving some of the problems which were indicated in the previous sections. Here are some possible generating and operating tactics for flexible systems:

(1) Both of the following sets of tactics can be used as solutions for the problems formed in the wine-bin and bookcase analogies.

   (a) The SCSD System: The use of a long-span (long roof span), demountable partition walls, integrated zoning under the roof for HVAC, and tight integration of structure and infills on differentiated modular grids.

   (b) The Marburg System, The independence of the envelope and the partitions from the load-bearing columns (the so-called "by-passing" solution) (Fig. 21).
Meeting of structural elements with non-structural, facade-partition elements requires "special" shorter "filler" elements. This is "joint-coordinated"

By-passing, allows maintenance of standard length of infill elements, and simplification of junctions/joints

(2) Building process, selected by a consortium and its working team has following advantages especially when compared to the seed analogy:

(a) A consortium and its working team can set up an intimate relationship between client and architect, so that the architect can take into account all important user's requirements as much as possible, compared with the organization in a conventional building process, in which client cannot operate enough control over architect's work. A new relationship with the manufacturer and the contractor, particularly in the prebidding conference can shorten the time of project, so that they can share the economic benefits resulting from savings due to the shortened time.

(b) The use of performance specifications by a consortium, and early bidding for each package of building jobs by prebidding conference can accommodate technical development by manufacturers who can have more assured time to develop, simultaneously enable manufacturers to have a system of mass production and thereby obtaining better economies of scale.
4. CONCLUSION; STRATEGY

4.1 Open System vs. Closed System

4.2 Dual Structure

4.3 Programming
4.1 Open System vs. Closed System

Though analogy is a helpful tool to analyze what the problem is in a certain context, it can not give an operational answer to the problem. Nonetheless, the material in Chapter 3 shows that the problems associated with past developments of building systems, especially for housing, lie primarily in the relationship between clocklike systems and cloudlike systems, as well as in the relationship between technology and architecture.

Since clocklike systems and cloudlike systems respectively resemble closed systems and open systems in building, they can also be respectively defined as a closed system and a open system as follows:

(1) Closed systems: A system in which components or subsystems are peculiar to that system and cannot be combined with those of other systems. Hence, the final product is predetermined and fixed over time.

(2) Open systems: A system in which components or subsystems are interchangeable with those of other systems. Hence, the final product is not predetermined but predicted and is not definite over time.

In the past development of housing systems, the rationalization and the standardization used in closed systems of industrialized housing - which aim at the optimum utilization of labour, building elements, tools and equipment, with the realization of economies of scale for mass production - have led to the loss of identity,
individuality, and privacy in both the internal and external housing environments. For example, the extensive use of a single system on a large scale in an industrialized building project has yielded problematic results. That is, repetition has led to monotony. Furthermore, the single closed system does not respond to the social and/or technical obsolescence which result from socio-economic change and rapid development of technology over time. Though the purpose of standardization and rationalization was to improve both quality and quantity, it has resulted in an actual deterioration of the housing environment over time, due to obsolescence and inability to adapt to change.

Industrialized housing can be improved by developing flexible systems, such as hierarchical open systems, which allow for variety in housing design, adaptability to change, and more user participation. Such a system may well be composed of hierarchical sub-systems which are produced either in factories or by conventional means. If conventional means are used, they should be based on the use of materials, sections, and units which are adapted to be compatible with open systems approach, even by conventional handicraft methods following plans and specifications for an individual building. If hierarchical open systems are applied to develop flexible systems, the use of many subsystems in even a large-scale housing project will can satisfy the various needs of dwellers who may live in such mixed types of
housing – so called multi-dwelling units.

Considering hierarchical open systems as appropriate flexible systems, the study of open systems which were analogized with the wine-bin, the bookcase and the chess game, shows that the systems belonging to the chess analogy have generally more flexibility in the design, the construction, and the use of buildings than the other types of systems belonging to the wine-bin and the bookcase analogies. Simultaneously, the development of these systems belonging to the chess game analogy, can solve other problems which lie in the relationship between technology and architecture, and which are caused by existing modes of financing, marketing, land use, and management conditions. Thus, the chess analogy reveals the most intrinsic characteristics of open systems, in contrast to closed systems, and the ensuing potentials for greater possibility to provide variability, as shown in the following comparison:

<table>
<thead>
<tr>
<th>OPEN SYSTEM</th>
<th>CLOSED SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>many kind of subsystems and components providing a</td>
<td>a kit of parts providing a limited number of possible</td>
</tr>
<tr>
<td>unlimited number of possible assemblies</td>
<td>assemblies</td>
</tr>
<tr>
<td>modular coordination</td>
<td>internal coordination and control capacity</td>
</tr>
<tr>
<td>planning grids</td>
<td>planning grids (in some cases)</td>
</tr>
</tbody>
</table>
In order to improve open systems, the following considerations should be kept into mind as follows:

(1) The compatibility and the interchangeability of subsystems and components should be achieved by the adequate use of dimensional coordination, especially, with regard to jointing problems and performance specifications, thereby providing greater operational variety.

(2) Team cooperation and coordination, e.g., a consortium or a working team, should be developed, in order to perpetuate and maintain large continuous market could be maintained.
4.2 Dual Structure

The university residential building systems which were compared to the chess analogy and suggested to be appropriate for our concerns, are different in the organization of decision-making in operating flexibility for the Olympic Village building system. The owner of school buildings in school, usually a school distract, can control the desirable flexibility with the help of an architect over the relatively long-term life of the buildings. But, the ownership of Olympic Village usually changes from public to private or an other public agency. It means that there is a great possibility for the overall system to go wrong, due to the lack of flexibility provided in its individual systems and/or subsystems. The most economical way for preventing such a failure is to provide a physical framework for accommodating optimal flexibility which lies in the balance between monotony (rigidity) and excessive variety, or, in other words, between standardization and individualization.

As could be seen in the bookcase analogy, a physical framework can be regarded as a support for accommodating "detachable units", which can be fully interchanged to satisfy changing or differing user requirements in multi-dwelling units. It is crucial to separate the primary and secondary building elements into the dual structure. The decision for this separation is made in system design process which the generation of flexible system is dependent on the
prediction of the operation of flexibility in space and in the overall system over time. A desirable process of system design for support/infill systems is as follows:

1) Defining the operational flexibility by secondary elements, in order to express user requirements for future types of flexibility, thereby setting up the characters of each space and the possible arrangement of such spaces.

   a) Short-term flexibility: subdividability, functional variability and functional exchangeability of each room.

   b) Long-term flexibility: variability of size and number of rooms, variability of unit size, subdividability of unit size, and functional obsolescence of service infra-structure.

2) Identifying the physical variables which can serve the above operational flexibility: facades, shadings, balconies, moving partitions, doors and demountable partitions, as well as moving bath, moving kitchen, moving furniture, and moving storage space which have a rather high-level of hierarchy in a building.

3) Devising the objective scale, e.g. morphological box to measure the performance of operational flexibility which each group of sub-systems can provide.

4) Comparison and identification of the physical variables which are most sensitive to the requirements of the target user group and/or individuals.

5) Comparison of projected support and detachable units in terms of cost and performance specifications for technical and material requirements, as well as marketability for manufacturers, which generates feedback of this process.

6) Deciding on the choice of sub-systems for support and detachable units, and whether to select existing sub-systems or to develop new sub-systems by means of performance specifications.
Finally, such a support would also act as a "chess board" for a game of variety, and the detachable units could be seen as "chessmen" to be moved about according to the rules.

4.3. Programming

One of the steps in the systems approach is programming, which is a problem-seeking process, while design is a problem-solving process. The final result of programming is a statement of the total problem, which is composed of subproblems determined by four major considerations: function, form, economy, and time. Such a statement gives a sound basis for solving the problems. Therefore, the study in Chapter 1 was carried out to make such a program.

The character of programming may be either prescriptive, that is, specific with regard to physical solutions, or performance oriented, that indicates criteria for developing alternative solutions. Our concern is to suggest a building process which can be efficiently back and forth to be appropriate for the fast tracking approach within a systems approach. Hence, the final result of programming can be expressed as a performance statement to be used for the
selection of existing, i.e., already-developed products. The result will, therefore, shorten time needed for procurement and give more choice, rather than suggesting the specific solution.

The performance approach consists of following steps:
1) Clarification of user requirements
2) Definition of performance requirements
3) Development of parameters to satisfy these requirements
4) Test and evaluation of the usage of results.
5) Statement of performance criteria for physical solutions.

According to this study's concern, the first two steps are related to flexibility, the third step is a clarification of the physical variables which are related to the flexibility, while the fourth and fifth steps are for a measurement of satisfaction - how much flexibility each kind of system which may belong to such "chess" analogy as defined in chapter 3, has, when operating within its own such physical variables.

In dealing with the performance approach, it is necessary to keep the following considerations in mind. The resultant program would hopefully become an integral part of the general program, on which host country or host city would rely, in order to develop its specific program within its own context, thereby avoiding unnecessary risks.
(1) The program should be appropriate to select a flexible building system for the Olympic Village for its various forms and to provide adaptable functions.

(2) The forms for athlete housing are restricted to highrise buildings of slab and/or tower type.

(3) Future functions are restricted to public housing, hostel, hotel, or dormitories. The functions of dormitories may be more meaningful to study because the last Los Angeles Games used existing university dormitories for accommodating the athletes and their attendants successfully, by good management of the operation of the Games and the use of sports facilities, with reducing financial risks of host city.
* APPENDIX *

1) p.39

The study finds that under the conditions of time and place of comparative evaluation, high-rise buildings constructed on sites exceeding $2.85 per square foot would result in a savings of total costs per student housed. The study further indicates that with a building construction cost of $15 per square foot, it would be well to evaluate total cost comparisons when the land value is as low as $12.50 per square foot. The study assumes a relatively level site adjacent to improved streets and basic utilities. Special costs such as grading, demolition, or extension of campus roads and utilities should be indicated as part of the total land cost if these apply in a given case.

(University Facilities Research Center, 1963)

2) p. 40

Assemblies or prefabricated components:

Materials, sections, and units are used to produce, either on or off the site, a wide variety of complex components with definite dimensional and functional characteristics. These are called assemblies or prefabricated components, and include heating, sanitary, electrical and gas equipment; wall and floor panels; furniture; doors; windows; stairs; lintels; and other building elements.

3) p.40

Carlo Testa proposed the definition:
"Industrialization is a process, which by means of technological development, organizational concepts and methods, and capital investment, tends to increase productivity and to upgrade performance."

4) p.42

The employment ratio is the ratio of employment to working age population. Some economists think that the employment ratio is more useful for diagnosing the severity of an economic slowdown than is the unemployment ratio.
5) p. 42

The balance of payments is a country's balance of trade plus other financial transactions such as international loans. It is a systematic record of all economic transactions between residents of a country and residents of the rest of the world (including international institutions) in a given period of time, usually a year. If such a balance shows a net inflow, it is said to be "favorable" or surplus." A persistent substantial deficit usually results in a depreciation of the currency in question on the world exchange markets.

6) p. 43

As governmental and corporate agencies move into the home-building industry, the old architect/client/builder trio becomes obsolete. In its place are management teams, economists, market analysts, manufacturers, transporters, and computer programmers. Hence, the potential for monopolies, extinction of "little" entrepreneurs, and the inefficiency and inertia of bureaucracy can result.

7) p. 43

A few large companies, once established, can lower prices to eliminate the smaller competing firms. When the competition is removed, prices could go up-- and the consumer would have no choice but to accept the products offered.

8) p. 55

Rationalization means the use of organizational, planning and control techniques in building to improve quality and increase productivity. It aims at the optimum utilization of labour, building elements, tools and equipment.

9) p. 58

The Authority of Hertfordshire County in Great Britain developed flexible school-building system in order to cope with the rapidly increasing school population and to solve the problem of a shortage of skilled labor. This system was designed as a set of components-structural elements, windows, roof deck units, etc., which could be handled and assembled easily with a minimum of building labour, and which would
still produce a wide range of different buildings for different requirements. The design of each school was to be treated on an individual basis so as to meet the special conditions of the locality and the educational purpose of the school. (The Story of CLASP)

10) p.58

Modular Coordination is a system desired to co-ordinate the sizes of factory-made building parts with the designs of buildings. It is a method by which the dimensions of standard building components and of the buildings which incorporate them are related to each other by a common unit of size. This unit, which is both a common denominator of all the sizes, a dimensional factor and an increment of sizes, is called "The Basic Module", which derives from the Latin word "Modulus", meaning a small measure." (Modular Co-ordination European Productivity Agency, 1961)

11) p.61

In the 1960s, the Archigram Group was composed of the young London architects Peter Cook, Warren Chalk, Dennis Crompton, David Green, et al. Their twentieth century visions followed those of Buckminster Fuller and Paolo Soleri. But, the former have had a more practical effect than those two architects. The core of Archigram's thinking was the idea of metamorphosis, the continually changing but always existing environment. They suggest applying innovative technology to real urban problems by inventing new artifacts and new situations. They made an architectural statement in the "Walking City", the "Plug-in City", the "Living Pod", and the "Instant City", as shelter and its urbanism.

12) p.61

The Japanese Metabolist group was composed of the four architects-Kurokawa, Kikutake, Maki, Otaka - and one architectural critic - Kawazoe. They worked with Kenzo Tange on the Megastructure to solve the expanding urban problem. Their theme was the separation of city elements into long-life and short-life ones, so that this organic urban fabric can accommodate change, mainly by shafts, bridges, and prefab modulars, utilizing high technology.
'Operation Breakthrough' was set up by Housing and Urban Development agency (HUD), to invite proposals from consortia of designers and developers. Its approach was influenced by the adoption of industrialized building by governments in Britain and other European countries during the sixties. Another factor to influence this approach has been the success of the Ehrenkrantz work with SCSD and UABS, and its implied suggestion that such an approach could be applied in other areas. Habitat, at the Montreal Expo 67, has also renewed popular interest in the possibilities of such an approach.

Operation Breakthrough is a broad residential development program designed to resolve a multitude of problems in order to make available quality housing in large quantities. It aims to do this by utilizing modern design and technology, and through contemporary approaches to financing, marketing, land use, and management. One major objective of the program is to demonstrate that with the kind of large, continuous market enjoyed by the manufacturers of other consumer products, producers of housing in volume can realize economies of scale: they can recover their investment—in research and development, in improvements to their design methods and in plants and equipment necessary for volume production.

Evolving House (Expandable Dwelling Unit): Part of the dwelling unit has services, utilities and partitioning. This portion may be finished or unfinished. An additional area is available for future growth. This area of growth can be provided for with or without services, finished or unfinished.

Core house: a physical structure, generally comprising a bathroom and kitchen with possibly a single, unfinished room adjacent.
Megastructure: very large multi-functional urban complexes containing transient smaller units adaptable to changing needs.

Karl Koch designed the Acorn House in 1947 and the Techbuilt House in 1953. Based on his experience in these, he developed his techcrete systems, large spans of hollow core slabs (32 ft), to be used in large scale apartment buildings in Roxbury near Boston, in 1965. His proposal in the Breakthrough programme was then made on the basis of his schemes for prefabricated methods in building. In spite of containing valuable ideas for the development of flexible housing, the Techcrete system has received less publicity because of a lack of long-term governmental support.

The Acorn (1947) was a demountable house built by timber and steel construction: one that can be set up, taken down, trucked three or a thousand miles, and set up again as neatly as it began. It was designed as a two bedroom affair, 24 by 35 feet. It unfolds the bedrooms, living room and dining room from a central core containing the kitchen, bathroom and utilities. It is factory produced, moving as one package, by truck, to its site.

The techbuilt house (1953), a modular component design, was produced by Techbuilt Inc. The company arranged for the fabrication of timber structural posts and beams, exterior wall panels, roof and floor, according to specification, by producers in the corporation. That part of the package was shipped by the producers direct to the builder-dealers. Other parts, pre-hung doors and the like, bought by Techbuilt on a volume basis—were shipped to the builder responding to the client's requirements through the maker's regular channels of distribution. Techbuilt came, not so much a "package", properly speaking, but as a system of conveying components. As such, the manufacturing and distribution system established by Techbuilt was different from that of the majority of prefabricators: (source; Koch, "At Home With Tomorrow" and Russel, 1981)
* Bibliography *

"All the comforts of Home (Moscow's Olympic Village)", Time, Aug. 6, 1979, p. 76.


Dluhosch, Eric. Flexibility/Variability in Prefabricated Housing, Xerox University Microfilms, 1975.


Johnson, William Oscar. "The Olympic Get away. (Controversial
Lake Placid Olympic Village)," Sports Illustrated, April 9, 1979, p.20.


"The Race for Olympic," Deutsche Bauzeitschrift,


