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# **THE INTEGRATION OF TECHNOLOGY INTO HOME SPACE IN THE 2020S**

A thesis submitted in partial fulfillment of the requirement for the degree of  
Master of Fine Arts at Virginia Commonwealth University

by

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August, 2003

# Acknowledgement

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I would like to express my gratitude to all those who gave me the possibility to complete this thesis.

I am very grateful to Barbara Powell, Dr. Graham Patterson, and his wife, Carol Patterson, for their encouragement, comments, and help with my English.

I am thankful to Roy McKelvey whose fresh feedbacks influenced my thinking perspectives.

Words are inadequate to express my thanks to my thesis advisor Prof. Buie Harwood. I am deeply indebted to her whose help, stimulating suggestions, and encouragement helped me in all the time of research and writing of this thesis. I have yet to see the limits of her wisdom, her patience, and her selfless concern for her students.

Especially, I would like to give my special thanks to my wife Megan whose patient love enabled me to complete this work.

## **Abstract**

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Research on the current housing status in the United States, and the features of middle-class and high-end houses, revealed that home space consists of five spaces: living, work and study, resting, service and circulation. A meticulous look at the four-century American housing history disclosed that transformations in the five spaces were profoundly impacted by technology. To predict home space in the near future, research on future technology and lifestyle was performed. There will still be five home spaces, with new and improved components. Technology will bring greater comfort and flexibility to the home interior. Two design solutions for middle-class and high-end levels were projected for the 2020s.



# Table of Contents

---

LIST OF TABLES .....	vi
LIST OF FIGURES .....	vii
INTRODUCTION .....	1
Overview .....	2
Literature Review .....	3
Methodology .....	5
CHAPTER 1: HOME SPACE TODAY .....	6
Overview .....	7
Definitions .....	8
Present Housing Status .....	11
Middle-Class and High-End Houses .....	14
Conclusion .....	20
CHAPTER 2: HOME SPACE IN HISTORY .....	25
Overview .....	26
Typical Houses .....	27
Changes in Home Space .....	34
Impact of Technology .....	39

CHAPTER 3: HOME SPACE IN THE 2020S .....	41
Overview .....	42
Trends in the Future .....	43
Future Technologies around Home Space .....	46
Home Space in the 2020s .....	51
CHAPTER 4: MIDDLE-CLASS SOLUTIONS .....	64
CHAPTER 5: HIGH-END SOLUTIONS.....	79
REFERENCE LIST .....	95
VITA .....	99

## List of Tables

---

Table 1-1.	Features in All Occupied Housing Units, 1999.	12
Table 1-2.	Features in Single-Family Housing Unit, 2001.	12
Table 1-3.	Features of New One-Family Houses Completed in 2001.	14
Table 1-4.1.	Middle-Class Houses: Interior Features Used as Criteria for Evaluation.	16
Table 1-4.2.	Continued.	17
Table 1-5.1.	High-End Houses: Interior Features Used as Criteria for Evaluation.	18
Table 1-5.2.	Continued.	19
Table 1-6.1.	Home Space Comparison between Middle-Class and High-End Houses.	23
Table 1-6.2.	Continued.	24

## List of Figures

---

Figure 1-1. Appliances of today's home.	13
Figure 1-2. Features of primary spaces.	21
Figure 1-3. Relationships of all five home spaces.	22
Figure 2-1. Typical house plan developments in the 17th century.	27
Figure 2-2. Parson-Capen House, Topsfield, MA, 1683.	28
Figure 2-3. Floor plans of the Parson-Capen House, Topsfield, MA, 1683.	28
Figure 2-4. George Wythe House, Williamsburg, VA, 1774.	29
Figure 2-5. Floor plans of George Wythe House, Williamsburg, VA, 1774.	29
Figure 2-6. A typical Gothic Revival house of the 19th century.	31
Figure 2-7. Floor plans of a typical Gothic Revival house of the 19th century.	31
Figure 2-8. The Torrington, Modern Home No. 3355 of 1932.	33
Figure 2-9. Floor plans of The Torrington, Modern Home No. 3355 of 1932.	33
Figure 2-10. The hall of the Seth Story House, MA demonstrates a typical setting in the 17th century.	34
Figure 2-11. A typical hall in a 17th and 18th century house evidenced work activities.	35
Figure 2-12. The parlor of the Thomas Hart house, MA demonstrates a typical setting in the 17th century.	36
Figure 2-13. Typical outdoor privy, Barnstable County, MA.	36
Figure 2-14. A typical steep stair.	37
Figure 2-15. Hall of Gunston Hall, Mason Neck, VA, 1759.	37
Figure 2-16. Change of home space.	38

Figure 2-17. Sleeping with iron stove as the heating source.	39
Figure 2-18. Washstand and bath tub.	39
Figure 2-19. Balloon frame, isometric view.	40
Figure 3-1. Concept for Home Automation: “Next generation system of smart house”.	46
Figure 3-2. Aware House by BIRL of George Institute of Technology.	47
Figure 3-3. The working process of the fuel cells.	48
Figure 3-4. Electrochromic Glass that can adjust the color and transparency.	49
Figure 3-5. Volumetric 3-D Display.	50
Figure 3-6. Tomorrow’s laptop on a roll.	50
Figure 3-7. Concept for Fractal Robot.	50
Figure 3-8. Relationships of home spaces in the 2020s.	51
Figure 3-9. Inspiration from nature.	52
Figure 3-10. Occupants may have different needs according to their activities and time.	52
Figure 3-11. People will be able to meet others within an all-enveloping tactile environment.	53
Figure 3-12. Concepts for a resizable living space.	55
Figure 3-13. Work and study should be able to happen in one place with the same furnishings.	56
Figure 3-14. Ideas for a joint work and study space.	57
Figure 3-15. Prototype of health monitor which will be available by 2020.	58
Figure 3-16. Ideas for the future closet.	59
Figure 3-17. Groups of activities in the resting space.	59
Figure 3-18. Service center.	61
Figure 3-19. Groups of functions in the service space.	61
Figure 3-20. Different positions of primary spaces require dynamic circulation.	62
Figure 3-21. Flexibility and variation of the circulation space.	63

Figure 4-1. Study model for a typical middle-class house.	65
Figure 4-2. Conceptual ideas for a typical middle-class house.	66
Figure 4-3. Thinking process - primary spaces compositions, sections.	67
Figure 4-4. Components from the vertical view.	68
Figure 4-5. Components from the plan view.	68
Figure 4-6. Thinking process of living space usage.	69
Figure 4-7. First floor plan.	70
Figure 4-8. The living space is flexible in space size and furniture arrangement.	71
Figure 4-9. Thinking process of resting space.	72
Figure 4-10. Thinking process of work and study spaces.	73
Figure 4-11. Second floor plan.	74
Figure 4-12. Third floor plan.	75
Figure 4-13. Ideas for service space and circulation space.	76
Figure 4-14. Service space provides service to primary spaces through service centers on every floor.	76
Figure 4-15. Ideas for the application of future changes and new materials.	77
Figure 4-16. Elevations of final model.	78
Figure 5-1. Study model for a high-end house.	80
Figure 5-2. Conceptual ideas for a high-end house.	81
Figure 5-3. Composition of spaces.	82
Figure 5-4. Living space floor plan.	83
Figure 5-5. Considerations for resizable living space.	84
Figure 5-6. Work and study space floor plan.	85
Figure 5-7. Ideas for work and study space.	86

Figure 5-8. Resting space first floor plan.	87
Figure 5-9. Resting space second floor plan.	88
Figure 5-10. The service space is underneath primary spaces and provides service through service centers.	89
Figure 5-11. Ideas for service spaces.	90
Figure 5-12. Primary spaces may move their positions to meet various needs.	91
Figure 5-13. The wall of the living space may be transparent to receive sunshine and observe a beautiful view.	92
Figure 5-14. The wall of the living space may change the transparency to block the view.	92
Figure 5-15 The walls, floors, and furnishings may also change color and texture to create a different mood or character.	93
Figure 5-16 The walls, floors, and furnishings may also change color and texture to create a different mood or character.	93
Figure 5-17. Elevations of final model.	94

# INTRODUCTION

CHAPTER 1

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5



## Overview

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Home space means the physical interior environment within a housing unit. Exploring the home space integrated with technology will be valuable to interior designers in the near future as the impact of technology expands in the design field. It will also be valuable to scientists, so they can make technology serve people better.

In Chapter 1, current housing status and features have been studied. Home space consists of three primary spaces: living, work and study, and resting spaces; and two support spaces: service, and circulation spaces. Many of these spaces incorporated appliances with high technology that became standards for most homes. The features and relationships of the home spaces of middle-class and high-end houses are very similar, even though the houses of the upper class have larger spaces with more variations.

In Chapter 2, the transformation of home space in the four-century housing history and the

impact of the technology development have been studied. Technology impacted home space in two significant ways. It changed the lifestyle which affected people's activities and needs for home space, and it also brought new appliances and devices to the home space which necessitated adjustments in the interior.

In Chapter 3, current studies for future home space were reviewed. Work at home, increased leisure time, continuing education, and health care will be the most important trends in the next 20 years. According to these trends, future home spaces will be transformed to facilitate these changes. Activities at home will increase, with new activities added to the home space. Flexibility and variability will become new features of the future home space.

In Chapter 4, a prototype house is provided for the future middle-class level. And in Chapter 5, a prototype house is provided for the future high-end level. Conclusions from the research were reflected in both design solutions.

## Literature Review

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The evolutionary history of the home space and the influence of technology have been discussed in depth for years. Ford and Creighton (1951) pointed out the importance of technology in housing. They believe that the architectural history is "inextricably interwoven with the cultural history, the economic and political history and, most importantly, the technological history of the nineteenth century" (p. 3). Tobey (1996) indicated that from early last century, electrical modernization as a symbol of technology transformed the American home. Today, the developing technology has broader meanings, influences and transforms the home space in more and varying ways.

From the technological perspective, Gates (1995) thought that the changes in technology would continually impact architecture, and there would be more influence to the house evolution. His well-known futuristic home near

Seattle, Washington reflects this thought. Nicholas Negroponte (1995) described how advancements in computer technology and telecommunications will transform households, workplace, and educational institutions. He explains how this revolution will change the way we live, think, and interact with one another.

Friedman predicted that in a future home, while the exterior may not change a lot, "the interior will change, however, as a result of demographic, lifestyle, and technological evolution" (as cited in Sinha, 2000, p. 77). From a designer's perspective, Schousboe (1993) indicated that "the home of the future - from its furniture to its landscaping - will accommodate the distinct needs, values, and lifestyles of tomorrow's homeowners" (p. 29).

In real practice, Bongers and Belien started "Living Tomorrow" in 1991. This project demonstrates how people will be living and working in the new century. Its intention is to create a future vision from a human approach

that reflects the transformation and trends in technology, society, and economy. In 1995, Broadband Institute Residential Laboratory (BIRL) of Georgia Institute of Technology wired a three-story house called “Aware House”, with broadband technology to study how technology affects and enhances home life. Since 1999, architect Kent Larson leads a group of researchers the House-N program in Massachusetts Institute of Technology to explore how technology can be used to design and build homes that will meet the people’s needs.

Riley organized an exhibition called “The Un-Private House” in the Museum of Modern Art in 1999. Twenty six houses represented the transformation in contemporary house design. In the book with the same name, Riley (1999) stated “the ascendancy of digital technologies throughout everyday life. In both theory and practice, ... [technology] has become a catalyst for contemporary architectural innovation and experimentation” (p. 12).

Current research and practices represent an exploration for the future home space from design and technological professionals. However, the ideal integration that incorporates both perspectives is rare to see.

## Methodology

---

The integration of technology into home space in the future is a broad and complex topic. Consideration must be given to the history of home architecture, trends in interior design and decoration, the evolution of technology and its impact on lifestyles in the home space, as well as the form all these will take in the future. Data were generally collected and analyzed from many sources: books, journals, magazines, reports, electronic databases, and websites.

For the historical part of this thesis, the principle source was published books. An Internet search for book reviews has been performed first, in order to find the best and most valuable books. Books on historical periods in the United States, architectural history, technology development, and domestic issues were reviewed. Several museums related to housing history and technological development were visited. In order to ensure a high degree of accuracy, each point was supported by at least two sources.

For current issues, data were collected mainly from reports from government agencies and non-profit organizations. Because of their advantages in conducting nationwide surveys, data from these reports have more accuracy than other sources. Again, data were supported by more than one source. Recently published house plans were the springboard for the detailed housing features study. In selecting house plans, their size, location, occupant, design firm, and style were carefully compared to the data from government sources to ensure the objectivity and universality.

For future trends and predictions, websites, online journals, magazines, and books were accessed. In order to get the most current and new information, data from the Internet were considered first. Data older than the mid year 2002 were rejected. Sources covered not only architectural/design fields, but technological, scientific, cultural, social, and futuristic fields as well.

## CHAPTER 1

# HOME SPACE TODAY

INTRODUCTION

CHAPTER 2

CHAPTER 3

CHAPTER 4

CHAPTER 5

## Overview

---

Home space refers to the physical interior environment within a housing unit. It is the term that will be used and discussed throughout this thesis.

Home space consists of five spaces: living, work and study, resting, service, and circulation. The first three are primary spaces, and the last two are support spaces.

According to recent documentation from the U.S. Census Bureau, there were more than 115 million housing units in the United States in 1999. According to the data from the Department of Energy, 63.1% of all housing units were single-family detached houses. Of this total, 89.2% of them have five or more rooms, and 78.0% of them have three or more bedrooms. Utilities were installed in almost all houses such as electricity, plumbing, heating, and telephone line, etc. Many incorporated

appliances with high technology that then became standards for most homes.

In order to study the interior spaces of the home, two groups of house plans have been selected and studied: representative examples of the middle and upper classes. Both groups were subjected to a set of evaluations. The findings from the study show that the relationships between the home spaces of the two groups are very similar, even though the houses of the upper class have larger spaces with more variations.

## Definitions

---

Our home is an important place in our life.

Bachelard (1958/1994) said that home is “our first universe, a real cosmos in every sense of the world. ... It is the human being's first world” (p. 4). At home, we cook, eat, sleep, bathe, read, work, think, talk, relax, entertain, and enjoy other activities. It is the starting point and ending point of our day. As Marcus (1997) noted, “home can mean different things to different people” (p. 4).

To describe precisely the focus of this research, a few definitions should be clarified.

**Home** means one's primary place of residence. Home has meaning as a physical structure such as a house or apartment. It also carries meaning in a social aspect as a family or a household, and in a psychological aspect as a refuge that provides protection.

**Housing Unit** is a term that refers to the physical structure of the home. As used in the census, it means "a house, apartment, group of rooms, or single room occupied or intended for occupancy as separate living quarters" (U.S. Census Bureau, 2000, A-9).

**Home Space** means the physical interior environment within a housing unit. In this thesis, the interior spaces of a home and their relationships are the primary focus. Consequently, the term "home space" will be used throughout the thesis.

Home space represents all interior spaces within the home. Each single interior space has various functions that support various activities. These spaces are typically referred to as "rooms". Some rooms normally have only one function, while others may have several functions or may be separated into smaller areas for specific activities. Based on the activities that people engage in at home, and the functions of each individual room and area, the “home space” can

be classified into five categories of spaces:

- Living
- Work and Study
- Resting
- Service
- Circulation

The criteria for each of the five spaces are defined below.

### **Living Space**

Living space is the public space of all family members for living activities; guests may also use this space. Living activities usually include family gathering, entertainment, cooking, eating, and other activities such as receiving guests.

The detailed activities may vary in different homes. Generally, these activities are performed daily and all family members participate in them. This space usually includes living room, family room, kitchen, and dining room.

### **Work and Study Space**

Work and study space is used for work and/or study. The detailed activities of this space vary, but may be activities like reading, writing, and using the computer. The purpose of these activities is to make a living, and/or to improve one's knowledge. Although these activities do not appear to have a direct relationship with family life, research shows there have always been examples of people doing work at home. Some housing units may have a separate room for work and study activities such as a library, a study room or a home office. Some may only have a part of room and share the space with other activities.

### **Resting Space**

Resting space is the private part of the home for people to have resting activities. These activities include sleeping, bathing, and other personal activities. Since these activities are private, each



family member has his or her own resting space. Some resting spaces may be shared with other family members, but usually they won't be used at the same time.

### **Service Space**

Service space provides the necessary support to all other home spaces. This space includes storage spaces such as closets, pantry, laundry room, garage, utility room, etc. People usually use these spaces only for a short time. These spaces are usually separate and close to another space that needs that service it provides.

### **Circulation Space**

Circulation space is used for transportation within the whole home space; it links all other spaces. Although all empty floor space on which people can walk might be considered

as circulation space, here we only refer to the circulation space between two or more other spaces. According to its function, the principal activity in this space is moving. For horizontal circulation, the form of the space can be a stand-alone space such as a corridor or a foyer; or a part of other spaces, such as a walk-through area in a family room. For vertical circulation, stairs are the most common form.

## Present Housing Status

---

Today's housing status and quality in America represents a very large topic with many aspects. In order to get an accurate view on this, data selected from the U.S. Census Bureau and the Department of Energy have been used to represent an overview of today's housing.

According to the latest *Current Housing Reports, American Housing Survey for the United States: 1999* by the U.S. Census Bureau, there were over 262 million people living in 115 million housing units in the United States. The types of housing units include: single-family house, apartment, mobile home, and trailer. Of this total, 89.2% are occupied. Within all occupied housing units, 77.7% are located inside Metropolitan Statistical Areas (MSA), 30.3% in central cities and 47.4% in suburbs; and 22.3% located outside MSA areas, which are rural

and open country areas. The average size of all occupied housing units is 1,730 square feet. On average, 2.55 persons live in each occupied housing unit. The median year of construction of all housing units is 1969. Table 1-1 shows detailed information about these features in all occupied housing units.

Other data are selected from the *Residence Energy Consumption Surveys: 2001* conducted by the Department of Energy. The single-family detached house is the most common construction type, which covers 63.1% of all housing units. Of this model, 60.0% are one story houses and 38.1% have two stories; 89.2% have 5 or more rooms (excluding bathrooms), 78.0% have three or more bedrooms, and 55.3% have two or more full bathrooms. Table 1-2 provides detailed data on these features of all single-family housing units.

From the same source, in Figure 1-1, these data show the percentage that have these appliances and equipment. Some of them already have

Table 1-1

*Features in All Occupied Housing Units, 1999.*

Architecture/ Interior	Average square feet		1,730
	Stories in structure	1	32.5%
		2	32.9%
		3	21.3%
		4 or more	6.7%
		Mobile homes	6.6%
	Number of rooms	4 or less	29.0%
		5	23.1%
		6	21.1%
		7 or more	26.9%
	Number of bedrooms	2 or less	40.9%
		3	41.9%
		4 or more	17.2%
	Number of bathrooms	1 or none	42.4%
		1 and one half	15.7%
		2 or more	41.9%
	Garage or carport included with home		58.9%
	Median built year		1969
Location	Metropolitan Statistic Area (MSA)	Inside MSA	77.7%
		In central cities	30.3%
		Suburbs	47.4%
		Outside MSA	22.3%
Resident	Number of persons	1	26.2%
		2	32.9%
		3 or more	40.9%

*Note.* Figures were calculated based on data selected from *Current Housing Reports, American Housing Survey of the United States: 1999*, by the U.S. Census Bureau.

Table 1-2

*Features in Single-Family Housing Unit, 2001.*

Architecture/ Interior	Stories in structure	1	60.0%
		2 or more	38.1%
		Split level	1.8%
	Number of rooms	4 or less	10.8%
		5	21.3%
		6	27.1%
		7 or more	40.9%
	Number of bedrooms	2 or less	22.0%
		3	51.7%
		4 or more	26.3%
	Number of full bathrooms	None or one	44.7%
		2	45.6%
		3 or more	9.7%
	Parking facilities	Garage	76.6%
		1	23.3%
		2	43.6%
		3 or more	6.0%
Resident	Number of persons	Carport	4.7%
		1	20.4%
		2	35.1%
		3 or more	44.5%

*Note.* Figures were calculated based on data selected from *Residential Energy Consumption Surveys: 2001*, by the Department of Energy. This table may be compared with Table 1-1, which presents similar data for all housing units; data were not available for some items on Table 1-1.

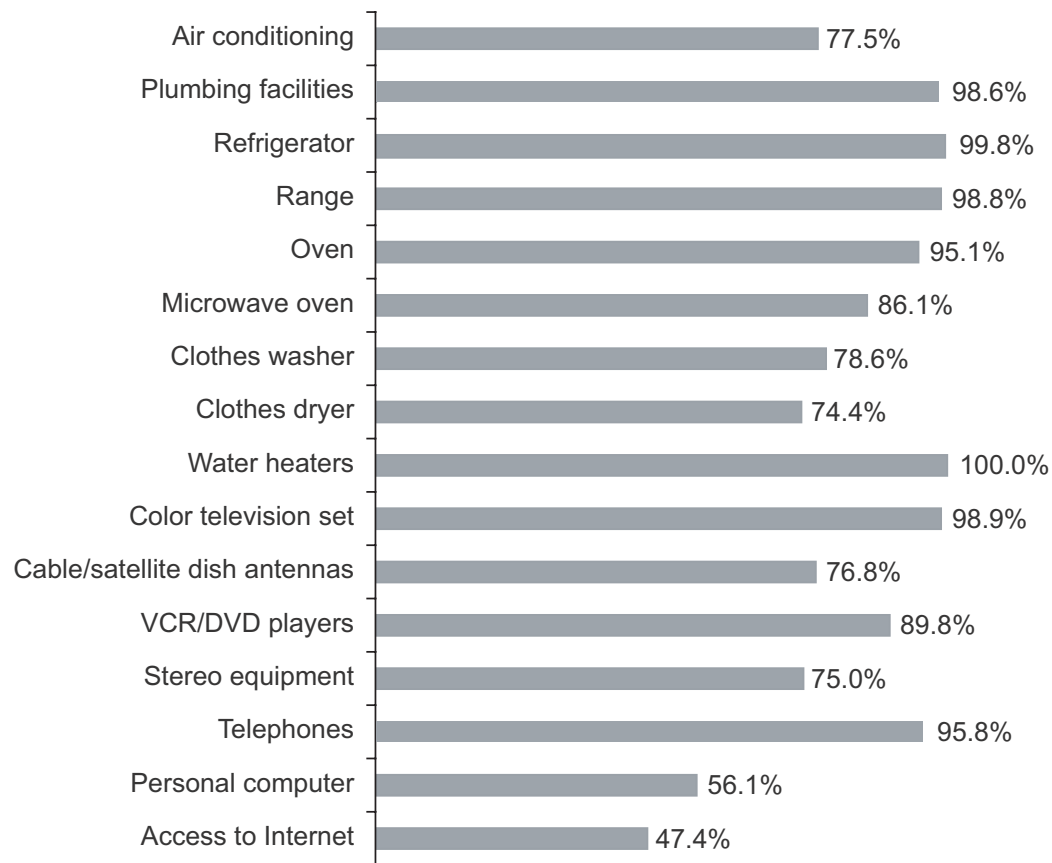


Figure 1-1. Appliances of today's home. Figures were calculated based on data selected from *Residential Energy Consumption Surveys: 2001*, by the Department of Energy.

become standard in most housing units, such as plumbing, heating, air-conditioning and telephone.

Since the data above reflect housing units that were built over an expanse of time (the median year of construction is 1969, see Table 1-1), the distinctive features of new housing units which reflect the current housing standard cannot be ascertained from Table 1-1 and 1-2. *Characteristics of New Housing*, also by the U.S. Census Bureau in 2001 (see Table 1-3), offers key data on features of one-family detached houses that were completed in 2000. A comparison of the data in Tables 1-1, 1-2 and 1-3 shows that new housing units are generally larger, and have more rooms, especially bedrooms and bathrooms.

Table 1-3

*Features of New One-Family Houses Completed in 2001.*

Architecture/ Interior	Average square feet		2324	
	Stories in structure	1	46%	
		2 or more	53%	
		Split level	1%	
	Number of bedrooms	2 or less	11%	
		3	52%	
		4 or more	37%	
	Number of bathrooms	1 and half or less	6%	
		2	38%	
		2 and half	35%	
		3 or more	21%	
	Parking facilities	Garage		88%
			1	7%
			2	64%
			3 or more	18%
Carport		1%		

*Note.* Figures were calculated based on data selected from *Characteristics Of New Housing: 2001*, by the U.S. Census Bureau. This table may be compared with Table 1-1 and 1-2, which presents similar data for all housing units; data were not available for some items on Table 1-1 and 1-2.

## Middle-Class and High-End Houses

The data from surveys gave an overview of today's American housing. In order to study the interior spaces and their relationships within the home, more detailed information such as the space components of home space, each space's position and feature, and the relationships among these spaces were explored.

The one-family detached house has been selected as the specific model for study, since this is the most common and typical type of housing unit (refer to Table 1-1). Middle-class houses and high-end houses have been selected as two focus levels. High-end houses can be described as more expensive than the average middle class U.S. citizen can afford. These are the houses that require their owners to have a high income and/or capital outlay. They are the types of houses that the upper class or the upper middle class would choose.

Middle-class houses reflect the average status and high-end houses reflect the most advanced features.

A total of 20 houses have been selected from *226 Best-Selling Luxury Home Plans* (Home Planners, 2000) as examples of middle-class houses. These 20 houses were designed by nine design firms from four regions; the average size is approximately 2,450 square feet (measured from plans), which is close to 2,324 square feet, the average size of a new one-family house completed in 2001 (refer to Table 1-3). These 20 house plans appropriately represent the middle-class level. For high-end houses, 13 houses were selected from *American Contemporary Houses* (Lyon, 1998) and *The Un-private Houses* (Riley, 1999). They were all custom designed and built after 1990.

Typical interior features related to issues of each space and the relationships among them were used as criteria for assessment and evaluation. These criteria were applied to both middle-class

and high-end houses to define their status and the differences between them.

Table 1-4 illustrates the results of middle-class houses, and Table 1-5 illustrates the results of high-end houses.

Table 1-4.1

Middle-Class Houses: Interior Features Used as Criteria for Evaluation.

<div><div>X</div>Included<div>Does not apply</div></div> <div><div></div>Not included</div>			House Plan Types																			
			Design 3537	Design 3310	Design 9229	Design 9542	Design 3479	Design 8603	Design 9632	Design 9673	Design 7214	Design 9898	Design 9854	Design 6615	Design 3309	Design 9067	Design 8109	Design 9619	Design 2883	Design 2871	Design 3636	Design 3634
Living	Living Room	close to entrance	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
		with fireplace		X		X	X		X	X	X	X	X	X			X	X	X	X	X	X
	Family Room	has separate family room	X		X	X		X							X	X						X
		far from entrance	X		X	X		X							X	X						X
		with fireplace	X		X	X		X							X	X						
	Dining Room	close to living room	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Kitchen	next to dining room	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		breakfast area/snack bar	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		pantry/closet	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
		near garage		X	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X
	Powder Room/Toilet	toilet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		bathroom sink	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Porch/Deck/Terrace	beside living room and/or family room	X	X			X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Work and Study	Work/Study	has separate space for work/study			X	X		X	X	X	X	X			X	X			X		X	X
		close to main entrance			X	X		X	X	X	X	X			X	X			X		X	X

(table continues)

Note. Samples were selected from 226 Best-Selling Luxury Home Plans (Tuscan: Home Planners, 2000).

Table 1-4.2

Continued.

<input checked="" type="checkbox"/>	Included	<input type="checkbox"/>	Does not apply
<input type="checkbox"/>	Not included	<input type="checkbox"/>	Floor of total floor(s)

Continued.

X

Included

Does not apply

Not included

1/2

Floor of total floor(s)

			House Plan Types																					
			Design 3537	Design 3310	Design 9229	Design 9542	Design 3479	Design 8603	Design 9632	Design 9673	Design 7214	Design 9898	Design 9854	Design 6615	Design 3309	Design 9067	Design 8109	Design 9619	Design 2883	Design 2871	Design 3636	Design 3634		
Resting	Master Bedroom	far from main entrance	X		X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	
		far from garage	X	X	X	X		X		X	X	X	X		X	X	X	X	X	X	X	X	X	
		story	2/2	1/2	2/2	2/2	2/2	1/1	1/2	1/2	1/1	1/2	1/1	2/2	2/2	1/2	1/2	1/1	1/2	1/1	1/1	1/1	1/1	
		walk-in closet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		bathroom with	toilet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			bathtub	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			shower system	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
			bathroom sink	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		balcony/terrace/pergola	X	X				X	X	X		X	X	X		X	X		X	X	X	X	X	
	Other Bedroom(s)	story	2/2	2/2	2/2	2/2	2/2	1/1	2/2	2/2	1/1	2/2	1/1	1/2	2/2	2/2	2/2	1/1	2/2	1/1	1/1	1/1	1/1	
		closet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
		bathroom with	toilet	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			bathtub	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			bathroom sink	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	the top floor is resting area only	X	X	X	X	X		X			X		X		X	X								
Service	Garage	part of the house	X	X	X	X	X	X		X	X	X	X		X	X			X	X	X	X	X	
		no room(s) above		X						X						X	X	X		X				
	Laundry	close to garage	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	
Circulation	Main Entrance	middle of the house's long side	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	
		covered porch/verandah/stoop	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Foyer	with closet	X	X	X	X	X		X	X	X	X	X		X			X	X	X	X	X	X	
		open above	X	X	X	X			X	X				X		X	X							
	Stairs	near entrance	X	X	X	X	X		X	X		X		X	X	X	X	X		X				
		close to the center of the plan	X	X	X	X	X		X	X		X		X		X	X	X		X				
Corridor/Gallery	link major spaces	X	X	X	X	X		X	X		X	X	X	X	X	X	X		X	X	X	X	X	



Table 1-5.1

*High-End Houses: Interior Features Used as Criteria for Evaluation.*

X

Included

Does not apply

Not included

			House Names												
			Kramlich	Slow	Digital	Hergott	Shorthand	Wakefield	Torus	WorkHouse	Y	Prince	Israel	Krueck	Moss
Living	Living Room	close to entrance	X			X	X	X	X	X		X	X	X	X
		with fireplace		X			X				X		X		X
	Family Room	has separate family room						X							
		far from entrance						X							
		with fireplace													
	Dining Room	close to living room	X	X	X	X	X	X	X	X		X	X	X	X
	Kitchen	next to dining room	X	X	X	X	X	X	X	X	X	X	X	X	X
		breakfast area/snack bar	X	X					X	X	X		X	X	X
		pantry/closet	X	X	X	X	X	X	X	X	X			X	X
		near garage/carport	X	X	X	X		X	X	X		X	X	X	
	Powder Room/Toilet	toilet	X	X	X	X	X	X	X	X	X	X	X	X	X
		bathroom sink	X	X	X	X	X	X	X	X	X	X	X	X	X
Porch/Deck/Terrace	connect to living roomm and/or family room	X	X		X	X	X	X	X	X	X	X	X	X	
Work and Study	Work/Study	has separate work/study space	X		X	X	X		X	X			X	X	X
		close to main entrance	X				X		X	X					

(table continues)

*Note.* The first nine houses were selected from *The Un-private House* (New York: Museum of Modern Art, 2000) by T. Riley; the other four houses were selected from *American Contemporary Houses* (Paris: Telleri, 1998) by H. Lyon.

Table 1-5.2

Continued

X	Included		Does not apply														
	Not included	1/2	Floor of total floor(s)	Kramlich	Slow	Digital	Hergott	Shorthan	Wakefield	Torus	WorkHou	Y	Prince	Israel	Krueck	Moss	
Resting	Master Bedroom	far from main entrance		X	X	X	X	X			X	X	X		X	X	
		far from garage		X		X		X	X	X	X		X	X	X	X	
		story		2/2	1/2	5/5	2/2	2/2	2/2	2/2	3/3	2/2	2/2	1/1	2/2	2/2	
		walk-in closet		X			X	X	X	X	X	X		X	X	X	
		bathroom with	toilet	X	X	X	X	X	X	X	X	X	X	X	X	X	X
			bathtub	X	X		X	X	X	X	X	X	X	X	X	X	X
			shower system	X	X	X	X	X	X				X	X	X	X	
			bathroom sink	X	X	X	X	X	X	X	X	X	X	X	X	X	X
		balcony/terrace/pergola		X	X	X	X	X	X	X	X	X	X	X	X	X	
	Other Bedroom(s)	story		2/2	1/2	3,4,5/5		2/2	2/2	2/2	2/3	1/2	2/2	1/1	1/2	1,2/2	
		closet		X	X	X		X	X	X	X	X	X	X	X	X	
		bathroom with	toilet	X	X	X		X	X	X	X	X	X	X	X	X	
			bathtub	X	X	X		X	X	X	X	X	X	X	X	X	
			bathroom sink	X	X	X		X	X	X	X	X	X	X	X	X	
		the top floor is resting area only			X			X			X		X		X		
	Service	Garage/Carport	part of the house		X		X	X	X	X	X		X		X	X	
no room(s) above			X				X	X									
Laundry		close to garage				X											
Circulation	Main Entrance	middle of the house's long side		X			X			X	X			X	X	X	
		covered porch/verandah/stoop			X	X		X	X	X	X	X	X	X	X	X	
	Foyer	with closet			X			X							X	X	
		open above									X					X	
	Stairs	near entrance		X	X		X	X	X	X	X	X	X		X	X	
		close to the center of the plan		X	X			X	X	X	X		X		X	X	
	Corridor/Gallery	link major spaces			X	X		X									

## Conclusions

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After comparing the figures of all housing units, features of one-family detached houses, and selected houses of both middle-class and high-end houses, the features and relationships of today's American housing can be summarized as noted below.

### Primary Spaces

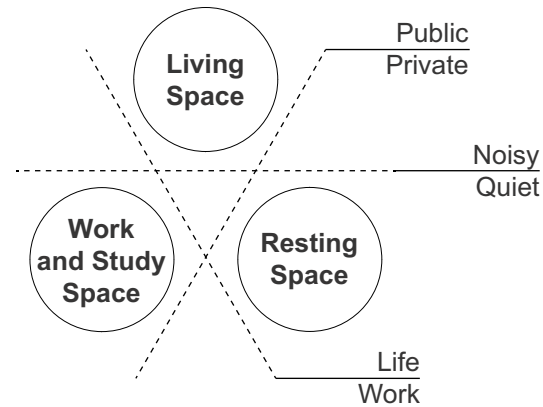
Living space, work and study space, and resting space are primary spaces, which have the following features:

1. All rooms or areas of a space are usually connected or are very close to each other, which form a whole group of relatively unattached space. This is because the activities common to one space are usually related to those in the nearby space. This allows family members to move easily from one related space to

another. For instance, in living space, the kitchen is always next to the dining room, and the dining room is always very close to the living room or the family room.

2. The family spends most of its time at home in primary space. This is true because a wider range of activities takes place in the primary space and also because activities such as sleeping, relaxing, working, entertaining, and sleeping, which can take a long time, utilize primary space.
3. Within the three primary spaces, living space is relatively noisy compared to work and study space and resting space. Resting space is private space while living space, and work and study space are public spaces (see Figure 1-2).
4. Living space is usually located in the front part of the house and connects directly to the main entrance. Resting space is usually located far from the main entrance. In multi-floor houses, resting space is usually not located on the same

Figure 1-2. Features of primary spaces.



floor as the main entrance. Work and study space does not always have a fixed position. It can be found next to living space, or an extra bedroom can be turned into work and study space. Sometimes, it is in the basement or the garage.

### Support Spaces

Service space and circulation space are considered as support spaces, not because they are less important than the primary spaces, but because of their attributes:

1. Support spaces are usually dispersed in

the home space. Areas/rooms of support are not physically grouped together. This is because primary spaces must have service and circulation in close proximity.

2. Support spaces are usually located in “hidden” places that are not easily noticed. For instance, the utility room is always in the back of the house with a closed door.
3. Support spaces are often used for a short period of time. Once the special purpose activities are performed, family members leave the area. Circulation space is only used for moving among and between other spaces.

### Relationships

According to the discussions above, primary spaces are three relatively individual groups of spaces, and support spaces are dispersive and mixed into primary spaces. The relationships are illustrated in Figure 1-3.

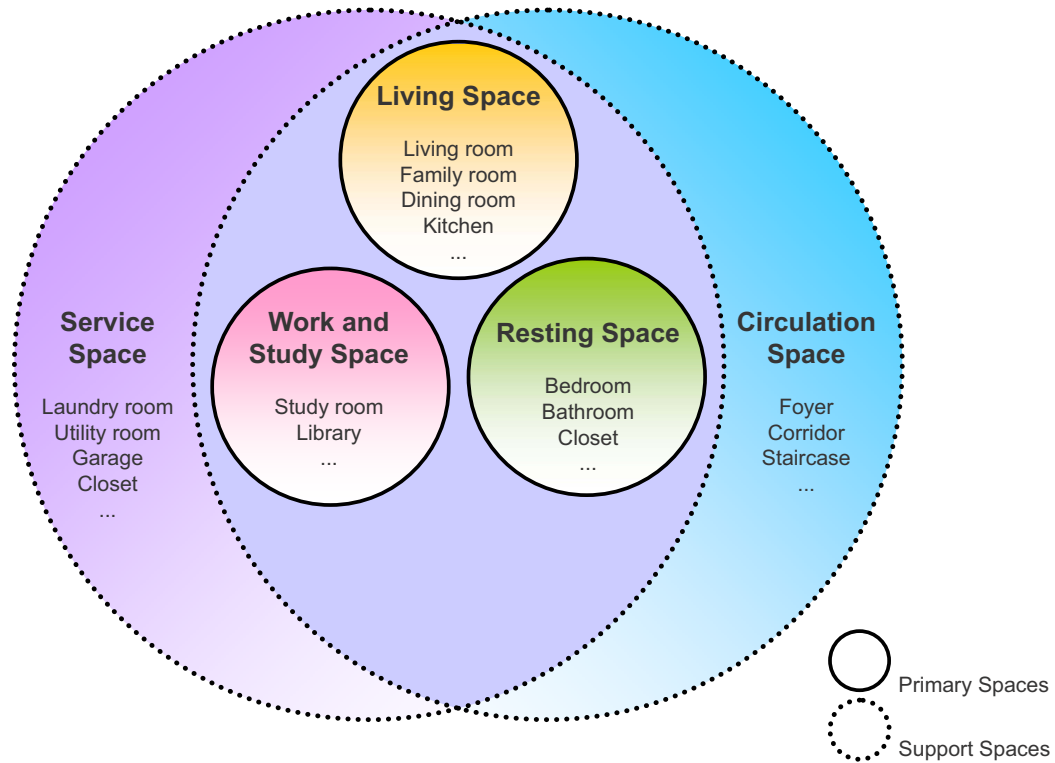


Figure 1-3. Relationships of all five home spaces.

### Middle-Class vs. High-End

It is interesting to find that middle-class and high-end houses do not have obvious differences in home space components. They all have the five spaces of living, work and study, resting, service, and circulation. The locations of these home space components within the house are similar in both models. Both have similar relationships among the primary spaces as well. Each of them has similar small areas for support space functions. High-end houses have more space in each of the home space components and offer more flexibility and variety in space combinations in floor plan designs.

Table 1-6 lists the detailed comparison information between middle-class and high-end houses.

Table 1-6.1

*Home Space Comparison between Middle-Class and High-End Houses.*

Middle-Class Houses			High-End Houses	
35% houses have one story; 65% houses have two stories; no house has three or more stories (basement is not included).	Stories	General	Stories	8% houses have one story; 77% houses have two stories; 15% houses have three or more stories (basement not included).
75% have a living room/great room/gathering room, which covers both formal and family living activities.	Living Room	Living	Living Room	92% have a living room/great room/gathering room, which covers both formal and family living activities.
All living rooms/great rooms are very close to main entrance.				77% living rooms/great rooms are very close to main entrance.
79% living rooms/great rooms have fireplaces.				38% living rooms/great rooms have fireplaces.
The family room/family area is a longer distance from the main entrance than the living room/living area is.	Family Room		Family Room	The family room/family area is a longer distance from the main entrance than the living room/ living area is.
All dining areas are very close to living room.	Dining Room		Dining Room	92% dining areas are very close to living room.
All kitchens are next to dining room.	Kitchen		Kitchen	All kitchens are next to dining room.
All kitchens include a breakfast area, or snack bar which can serve for informal dining.				62% kitchens include a breakfast area, or snack bar which can serve for informal dining.
95% have pantry/closet.				85% have pantry/closet.
94% are close to garage.				83% are close to garage.
All have a powder room/toilet, including toilet and sink.	Powder Room/ Toilet		Powder Room/ Toilet	All have a powder room/toilet, including toilet and sink.
85% of them have access to porch, deck, or terrace from living room/family room.	Porch/Deck/ Terrace		Porch/Deck/ Terrace	92% of them have access to porch, deck, or terrace from living room/family room.
60% have separate study room/office/den; within these houses, all study room/office/den are close to main entrance.	Study/Office	Work and Study	Study/Office	69% have separate study room/office/den; within these houses, 44% of these study room/ office/den are close to main entrance.

(table continues)

*Note.* Figures were calculated based on results from Table 1-3 and 1-4, which were originally based on houses selected from *The Un-private House* (New York: Museum of Modern Art, 2000) by T. Riley, and *American Contemporary Houses* (Paris: Telleri, 1998) by H. Lyon.

Table 1-6.2

*Continued.*

85% located far from the main entrance.	Master Bedroom	Resting	Master Bedroom	77% located far from the main entrance.
95% located far from the garage.				92% located far from the garage.
All have walk-in closet.				All have closet, 77% are walk-in closets.
All have its own full bathroom, including sink, bath tub, and toilet; 90% of them have separate bathtub and shower system.				All have its own full bathroom, including sink, bath tub, and toilet; 69% of them have separate bathtub and shower system.
70% have balcony, or terrace, or pergola.				All have balcony, or terrace, or pergola.
54% of multi-floor houses have the master bedroom not on the main-entrance-floor.				92% of multi-floor houses have the master bedroom not on the main-entrance-floor.
92% of multi-floor houses have other bedroom(s) not on the main-entrance-floor.	Other Bedroom(s)	Resting	Other Bedroom(s)	67% of multi-floor houses have other bedroom(s) not on the main-entrance-floor.
All have closet.				All have closet.
All bedrooms share one or more full bathrooms with other bedroom(s).				All bedrooms share one or more full bathrooms with other bedroom(s).
All bathrooms include sink, toilet, and a bathtub or shower system.				All bathrooms include sink, toilet, and a bathtub or shower system.
77% of multi-floor houses have the top floor as resting space only.		Service		42% of multi-floor houses have the top floor as resting space only.
90% have garage; within these houses, 89% of these garages are part of the house, others have covered access to the house.	Parking Facility		Parking Facility	77% have garage/carport; within these houses, all garages/carports are part of the house.
95% are located in the center of the long side of the house.	Main Entrance	Circulation	Main Entrance	54% are located in the center of the long side of the house.
All are covered by porch/verandah/stoop.				85% are covered by porch/verandah/stoop.
All of them have a foyer.	Foyer		Foyer	85% of them have a foyer.
In all multi-floor houses, stairs are near the main entrance and close to the center of the house.	Stairs		Stairs	In 92% of multi-floor houses, stairs are near the main entrance; in multi-floor houses, 75% stairs are close to the center of the house.
85% have a separate circulation space such as corridor/gallery to link major spaces.	Corridor/Gallery		Corridor/Gallery	77% are using part of living spaces as circulation space to link other major spaces.

## CHAPTER 2

# HOME SPACE IN HISTORY

INTRODUCTION

CHAPTER 1

CHAPTER 3

CHAPTER 4

CHAPTER 5



## Overview

---

Since the future will be a part of history, predicting the evolution of home space in the future requires study of the history of home space.

In the four-century long history of American housing, four typical houses have been selected for study.

The Parson-Capen house in Massachusetts represents a 17th century house. It has a typical hall-parlor floor plan, which was small and simple. Many home activities had to share one room.

The George Wythe house in Virginia illustrates a typical Georgian house in the 18th century. The house becomes larger and symmetrical with more rooms. Unlike the other three samples, this one was only typical at the high-end level.

Houses in the 19th century showed irregular

floor plans. Some outdoor features had been merged into house, such as the privy/water closet/toilet. Technology's impact started to appear in home spaces.

Home spaces in the 20th century had lots of variations especially through architecture forms. The interior spaces closely resemble today's houses. More components in both structure and activities have been introduced to the newer home space.

Home spaces have changed through the evolution of history. Technology impacted home space in two significant ways. It changed the lifestyle which affected people's activities and needs for home space, and it also brought new appliances and devices to the home space which necessitated adjustments in the interior.

## Typical Houses

Today's houses are developed based on the European settlements about four hundred years ago. Home space has changed in many ways over the last centuries. In order to understand the similarities and differences throughout history and to discover what drove these developments, a study of typical home spaces is needed.

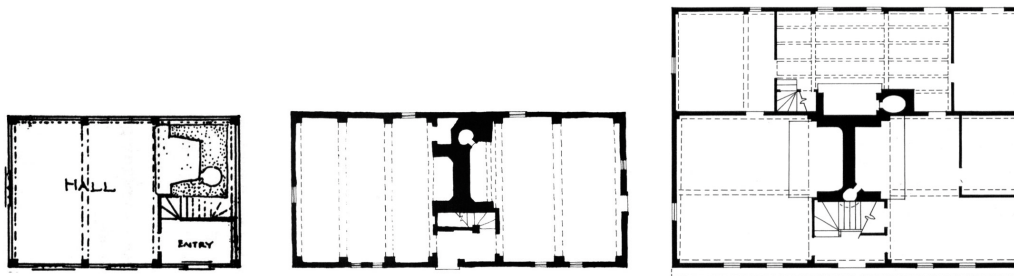


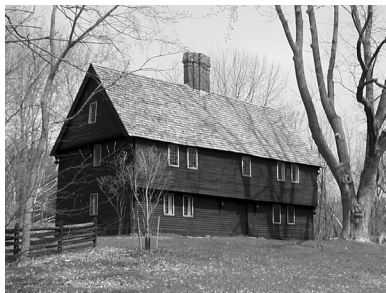
Figure 2-1. Typical house plan developments in the 17th century. *Left:* One-room house plan. From *Early American Houses: A Glossary of Colonial Architectural Terms*, by N. Isham, 1967. *Middle:* Two-room house plan, another room was added to the plan on the right. From *A History of American Architecture: Buildings in Their Cultural and Technological Context*, by M. Gelernter, 1999. *Right:* Salt-box house plan, a lean-to was added to the plan on the back side. From *American Architecture: A History*, by L. Roth, 2001.

### 17th Century

When European settlers arrived in the New World, they built their first homes in their most familiar style, the medieval. The English Colonial had a more significant impact on house styles than the others reflecting Spanish, French, and Dutch influences.

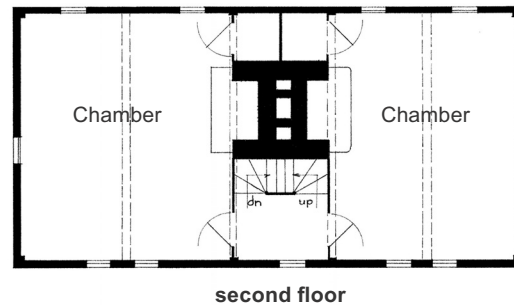
From New England to the Carolinas, agriculture was the primary economic base. The plantation system, which consisted of the planter's house, farm buildings and houses for workers was the most popular community style (Gelernter, 1999). Most of the population and houses were located in rural areas.

The basic house plan in this century was a one-room, two-story plan (Figure 2-1, left). Most farmers lived and worked in houses like this. By putting two basic units together, the two-room two-story plan was called the hall-parlor house (Figure 2-1, middle). Each of the four rooms was usually no larger than 20 feet by 20 feet. The

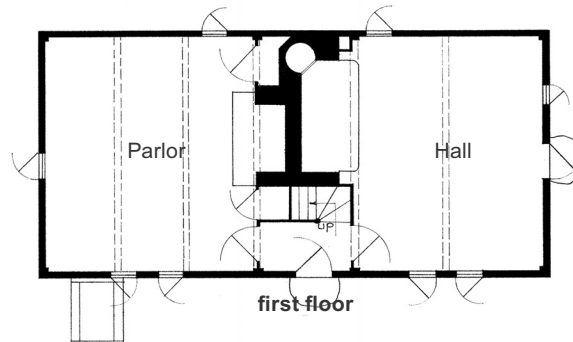


*Figure 2-2.* Parson-Capen House, Topsfield, MA, 1683. Photograph by author.

hall-parlor plan had been used as the standard house plan for the upper half of Colonial society, owners such as merchants and planters (Bushman, 1992). A lean-to could be added on to the back of the house when more space was needed. It is commonly known as the Salt-Box (Figure 2-1, right). The lean-to space was used as a cooking space and buttery, and sometimes included a small bedroom.



**second floor**



**first floor**

*Figure 2-3.* Floor plans of the Parson-Capen House, Topsfield, MA, 1683. From Library of Congress, HABS, MASS, 5-TOP, 1-.

The Parson-Capen house in Essex County, MA built in 1683 is a very typical hall-parlor house (see Figure 2-2 and 2-3). The hall is the multi-function room of the house. Cooking, eating, family gathering, and working, and sometimes sleeping happened in this space. It has a massive open-hearth, or half-contained fireplace, that provided the source of cooking, heating, and lighting.

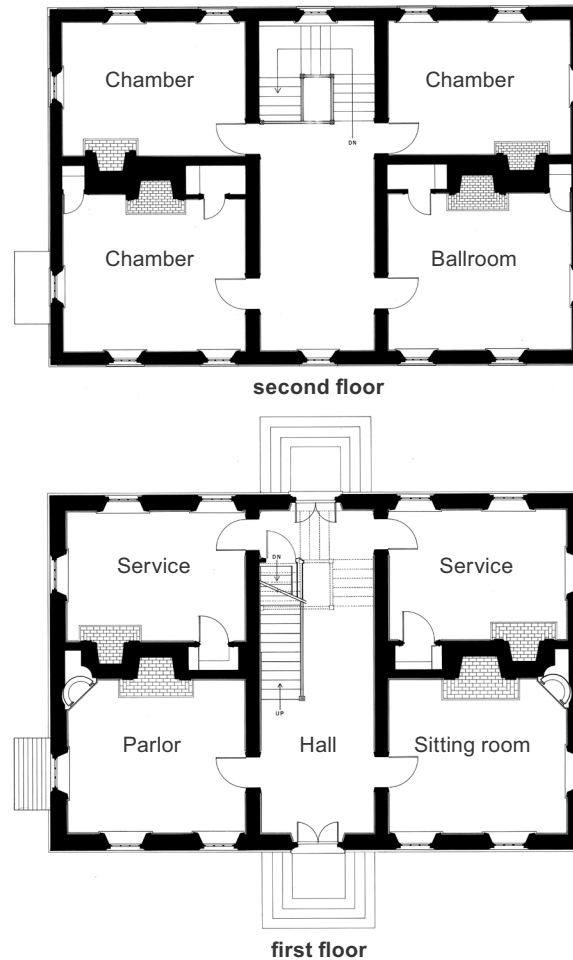
The parlor on the left was the formal guest receiving space with the best furnishings of the house; it was also the sleeping space for the parents.

Upstairs were two chambers for children and elders. The cellar was the place for storage, especially for food. The stairs were small, steep, and winding.

There were a few very tiny windows, which made the rooms dark.

The privy (water closet/toilet) was a small

building detached from the house. There were also additional work rooms with specific functions attached or set apart from the house.



*Figure 2-4.* George Wythe House, Williamsburg, VA, 1774. Photograph by author.

*Figure 2-5.* Floor plans of George Wythe House, Williamsburg, VA, 1774. From Library of Congress, HABS, VA, 48-WIL, 16-.

## 18th Century

From the 17th century until 1800 and beyond, most people still built and lived in vernacular houses with no major differences in the plan (Roth, 2001). Subsequently, a rectangular, hipped roof style called “Georgian” emerged in the 18th century as the most fashionable house for the wealthy elite.

In 1754, George Wythe built a house in Williamsburg, Virginia in the typical Georgian style (see Figure 2-4 and 2-5). In the middle of the double-pile plan, the central hall runs through the whole depth of the house to a rear door. On both sides are two larger rooms in the front and two smaller rooms on the back.

The parlor was a formal reception and entertaining space for tea, wine, cards, sometimes dancing, and above all conversation. Tables, chairs, and cupboards with ceramics were moved in; beds and other working furnishings were moved out from this space.

On the other side across the hall was the sitting room for the family, or sometimes a dining room. In some especially elegant houses, this room became another parlor for entertaining.

On the upper floor were mainly chambers for sleeping spaces. Sometimes there were other rooms upstairs used for entertainment, such as a ballroom, billiard room, etc.

The trend of this century was to move everyday service activities to the back of the house, or even to move them to outer buildings and cellars, especially for the kitchen and service quarters.

Enlarged sizes and increased numbers of windows improved the natural lighting.

An indoor privy began to appear at the end of this century, but only rarely (Baker, 1994). It was usually located on the first floor. Most houses were still using outdoor privies.

## 19th Century

With the rapidly swelling population in America, more houses, food, and clothing were needed which the old agriculture economy could not provide. The Industrial Revolution began at the end of the 18th century. During this time, many technological inventions for modern life appeared and came into use at home.

Less than 4% of the people lived in towns of more than 8,000 in the late 18th century. But by 1860, urban population increased to 20%, and 40% by 1900 (Gelernter, 1999). People moved to cities and lived in row houses. After the street car system developed around 1870s, people started to move out of the city, and the suburbs emerged.

In the late 18th century, many architectural styles appeared, such as Federal, Greek Revival, Gothic Revival, Renaissance Revival, Second Empire, Queen Anne, and Shingle.

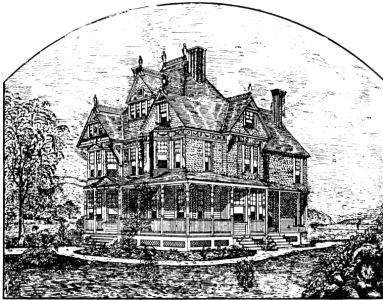


Figure 2-6. A typical Gothic Revival house of the 19th century. Design 16, Plate 6. From *The Palliser's Late Victorian Architecture*, by G. Palliser, and C. Palliser, 1978.

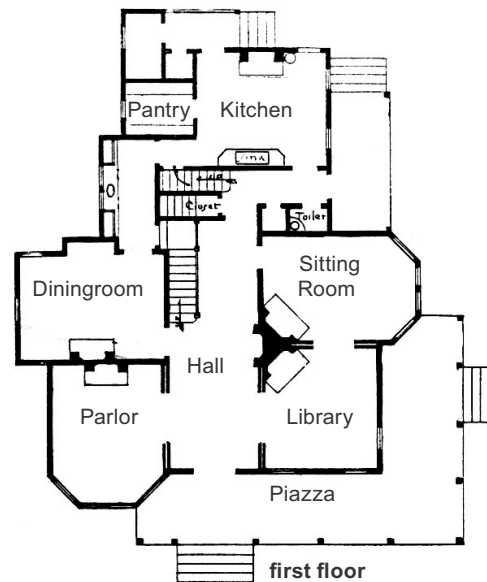
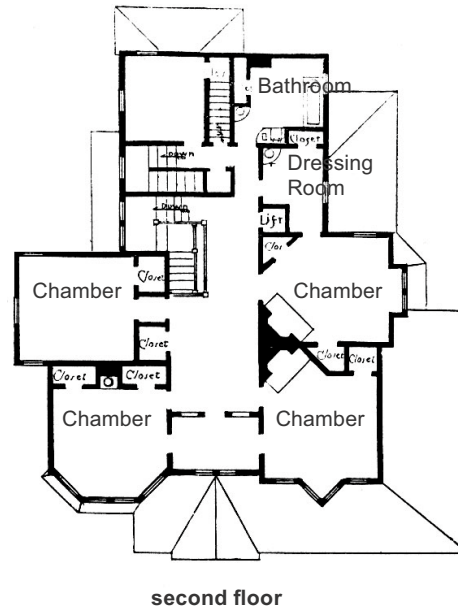


Figure 2-7. Floor plans of a typical Gothic Revival house of the 19th century. Design 16, Plate 6. From *The Palliser's Late Victorian Architecture*, by G. Palliser, and C. Palliser, 1978.

Figure 2-6 shows a typical Gothic Revival house around mid-19th century.

The house has an irregular plan. The parlor was in the front of the house, and served for formal entertainment and conversation. The library was also in the front part of the house. Family leisure activities, such as reading books, writing letters, and sewing took place in the sitting room.

Upstairs rooms were bedrooms (formally called chambers). Each bedroom has its own closet. The only bathroom was shared by the four bedrooms.

The service quarters were in the back part of the house. This part had been separated into small rooms for particular uses. The kitchen was probably equipped with a modern range, oven, roasters and other devices which were common in that century.

A large piazza (porch) was used to maintain the indoor temperature.

## 20th Century

Many new styles for residences appeared from the turn of the 20th century, such as the Craftsman Style, Bungalow Style, and Prairie Style. The development of Modernism in the 1920s and the Post-Modernism starting in the 1960s continued to impact the design of American houses. With the help of technology, the limitations of materials became less important. And architectural style and the function of the house became increasingly independent. After the 1940s, more than half of all household were considered middle class (Gelernter, 1999). Most families were buying new houses directly from the builders.

From 1908 to 1940, Sears, Roebuck and Company sold more than 100,000 homes through their mail-order Modern Homes program (Stevenson, 1986). They followed the popular house plans and focused on the middle class. Figure 2-8 and 2-9 show a typical house from the 1932 catalogue.

The living room on the first floor was the place for both formal and family living activities. The fireplace in the living room was the only one in the whole house. The dining room was now a separate room next to the kitchen. The adjacent kitchen was equipped with more appliances, and powered by new energy sources such as gas or electricity. The large kitchen usually included a breakfast area.

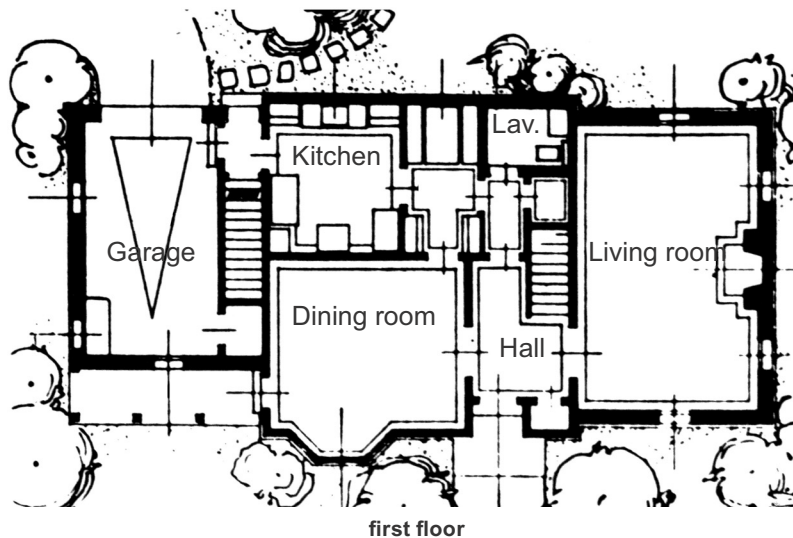
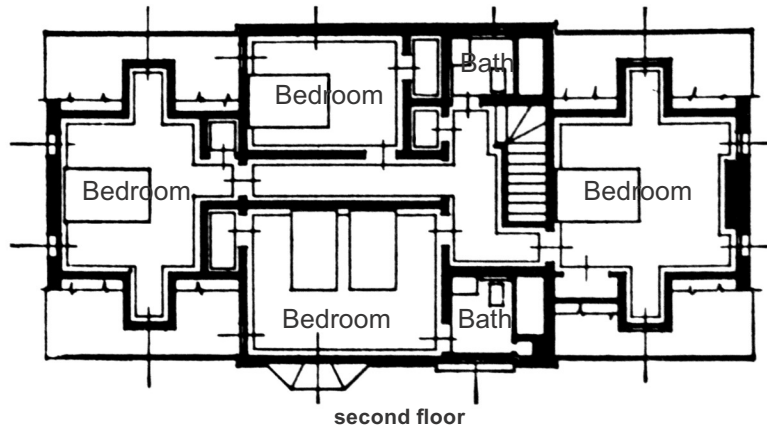
On the second floor were all the bedrooms. Each bedroom had its own closet for storage. Bathrooms with sink, bathtub, and toilet became common in the resting space; and there were usually two of them. Also, a half-bath appeared on the first floor in the living space.

The automobile became the standard means of transportation for American families in the 1920s. Because of this, the garage became a standard extension on a house (McAlester, 1984). Beginning in the 1950s, with the expansion of residential suburbs, many houses proudly put the garage in the front of the house.





Figure 2-8. The Torrington, Modern Home No. 3355 of 1932. From *Houses by Mail: A Guide to Houses from Sears, Roebuck and Company*, by K. Stevenson, 1986.



The garage size increasingly expanded to accommodate two or more cars. As a result of importance, the garage entrance to the house became the most heavily used.

Washing machines and dryers became standard appliances in the laundry room.

Air-conditioning emerged into common use in the 1950s (McAlester, 1984), which resulted in the subsequent reduction or elimination of porches.

Figure 2-9. Floor plans of The Torrington, Modern Home No. 3355 of 1932. From *Houses by Mail: A Guide to Houses from Sears, Roebuck and Company*, by K. Stevenson, 1986.



## Changes in Home Space

Throughout the four-century development of American housing history, it is obvious that the typical American home space was evolving. Typical changes are noted below.

1. The *size* of the average house became larger; the number of rooms, especially the number of bedrooms, increased; new rooms for new activities appeared in the home space.
2. The *shape* of the house plan, and the architectural forms became complex.
3. In primary spaces, *detached* areas/rooms associated with each space became *attached*.



Figure 2-10. The hall of the Seth Story House, MA demonstrates a typical setting in the 17th century. From *American Building*, by J. M. Fitch, 1972.

Generally, this evolving transformation made home space more comfortable and more convenient to serve people's growing needs.

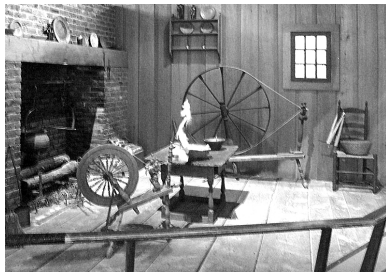
### Living Space

Living space consists of the space for family living activities and the space for receiving guests.

Family living space in the 17th century combined service space and working areas in one room, the hall. The hall functioned as a combination of today's kitchen, dining room, family room, and den (see Figure 2-10). Spaces for cooking and dining were later separated from this room. They were moved to the back part of Georgian houses in the 18th century. The fireplace was the activity center of the family living space because it provided warmth and heat. In 19th century middle class houses, one of the family living spaces came back to the front part of the house as a separate room, called the library or sitting room. Family gathering, reading, and some games were the main activities in this space. After heating improved with the development of the iron stove in 1840 and the central furnace in 1880 (McAlester

and McAlester, 1984), people no longer needed to confine their family living activities to the fireplace area. In the 20th century, the introduction of radio, television, and later VCR and DVD expanded the variety of family living and entertainment options. These activities were grouped into a new space called the family room.

In the 17th and 18th centuries, most houses had a parlor (also the master sleeping space) to receive guests. Therefore, the best furniture went into the parlor. In some very wealthy mansions of the 18th century, the sleeping function was removed from the parlor. Guest receiving, conversation and entertainment became the only activities of the parlor (it could also extend to other formal entertainment spaces on upper floors). This space was kept in the front part of the house, close to the main entrance. The name "parlor" had been used for this space for a long time, up until the early 20th century; it was later replaced by the name of "living room". With the development



*Figure 2-11. A typical hall in a 17th and 18th century house evidenced work activities. From Henry Ford Museum, Detroit. Photograph by author.*

of technology, people had more means to communicate with people outside the family, such as telephone, fax, email, online meeting, etc., and this meant that the frequency of using guest receiving space for traditional meetings declined.

The toilet did not become a part of living space until indoor plumbing and public sewer systems were developed.

### **Work and Study Space**

The meaning of work varied in different eras. Before the Industrial Revolution, most families lived in rural areas. Farm related work took place in the living space - the hall (see Figure 2-11); sometimes, one of the chambers could be used to do some work such as weaving. After the city and later the suburbs grew, the majority of family lifestyle became "city life" compared to "farm life". In most families, work and study were still not in home activities; so there were



Figure 2-12. The parlor of the Thomas Hart house, MA demonstrates a typical setting in the 17th century. Having a resting space component, such as a bed in the living space, was very common at that time. From *Images of American living: Four Centuries of Architecture and Furniture as Cultural Expression*, by A. Gowans, 1964.



Figure 2-13. Typical outdoor privy, Barnstable County, MA. From Library of Congress, HABS, MASS, 1-TRU,52-.

no separate spaces for these activities in most houses. Along with the development of communication technology, work and study at home became possible for more families in the late 20th century. As a result, more people began to use a part of other spaces or one bedroom for work and study.

#### Resting space:

Resting space consists of sleeping space and related spaces for personal use such as bathroom and closet.

Sleeping is probably the most important function of the home. A sleeping space was called a "*chamber*" until early 20th century, when chamber was replaced by the term "*bedroom*". The master bedroom was in the parlor on first floor in hall-parlor houses (see Figure 2-12), which doubled as the space for guest receiving. Several family members sharing one chamber was common practice until the 19th century,

when the number of chambers increased.

Other resting spaces were not commonly associated with the sleeping space before the 19th century. The outdoor privy (see Figure 2-13) and chamber pot served as a toilet. The privy began to move indoors in the 19th century. Bathing was once a kitchen activity. But with the help of the city sewer system and indoor plumbing, the modern bathroom with sink, bathtub, and toilet together appeared next to the sleeping space and became a part of the resting space in most houses from the end of 19th century. The space became larger because of the addition of traditional functions, such as brushing teeth, making up, cutting nails, taking medicine, and weighing.

#### Service space:

Service space provides services to other home spaces. In earlier centuries, service space consisted mainly of storage space, for example, the cellar, used primarily for food storage.



Figure 2-14. A typical steep stair. From *Old Houses on Nantucket*, by K. Duprey, 1986, p. 11.

Closets for clothes did not appear until the late 18th century. Garages became common in most houses after the mid 20th century as a reflection of the development of automobiles.

Other service spaces, such as the utility room and mud room, became standard in most houses when the location of furnace, clothes washer and dryer in the space became common.

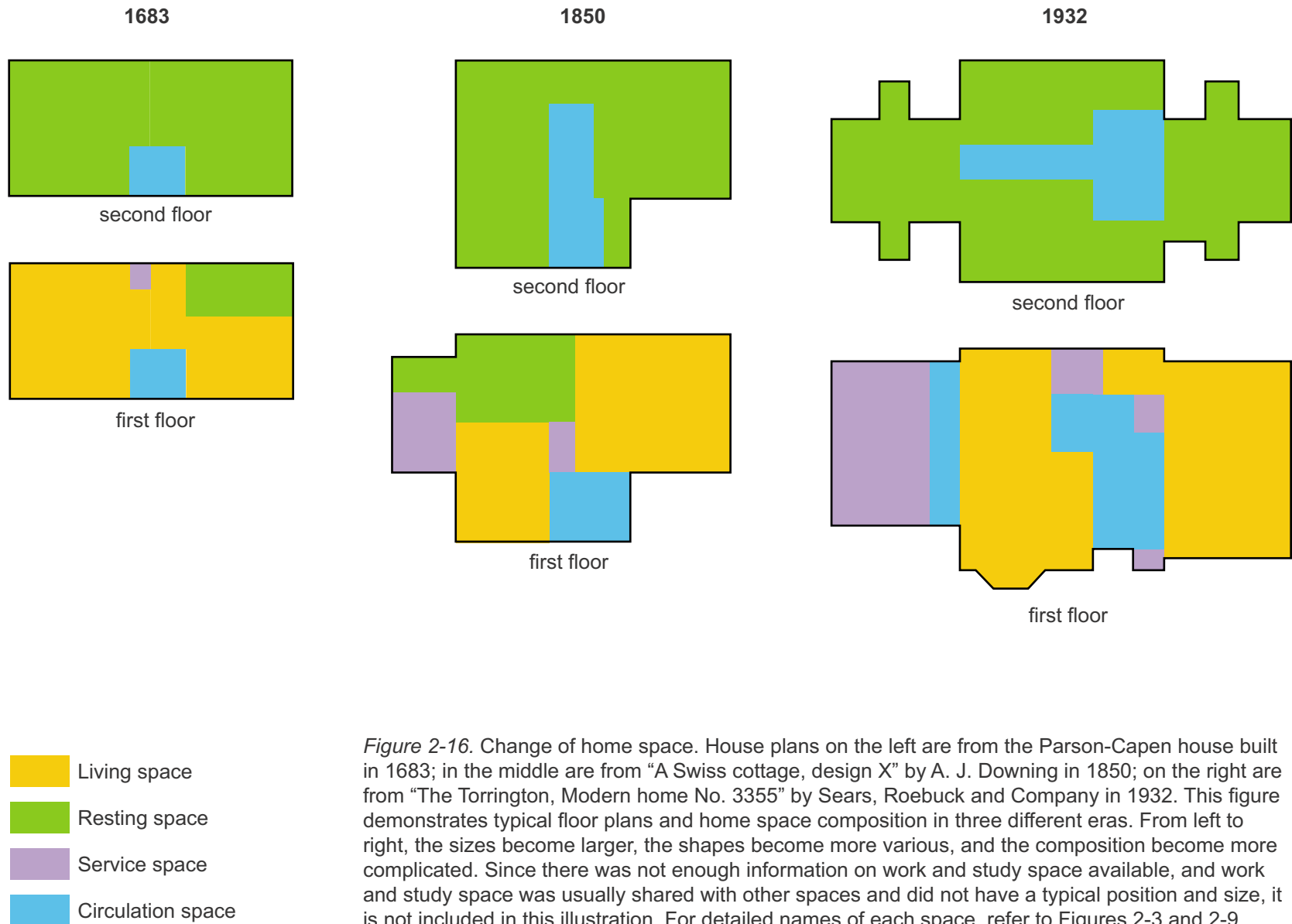
house became larger and the plan irregular. It extended from the staircase area to other areas as a separate space. The shape of this space varied in order to fit other spaces. Steps, ramps, and even elevators appeared, as new forms of circulation space developed in some 20th century houses.

### Circulation space:

Circulation space linked all other spaces. In the earliest typical houses, circulation space was limited to a tiny foyer and a windy, steep stair (see Figure 2-14). In the 18th century Georgian house, service space was the center hall with a grand staircase. It was larger and sometimes functioned as part of living space for guest receiving (see Figure 2-15). But the hall was still a space that contained the staircase. The function of passage became possible when the



Figure 2-15. Hall of Gunston Hall, Mason Neck, VA, 1759. From Library of Congress, HABS, VA, 30-LORT,1-.



*Figure 2-16. Change of home space. House plans on the left are from the Parson-Capen house built in 1683; in the middle are from “A Swiss cottage, design X” by A. J. Downing in 1850; on the right are from “The Torrington, Modern home No. 3355” by Sears, Roebuck and Company in 1932. This figure demonstrates typical floor plans and home space composition in three different eras. From left to right, the sizes become larger, the shapes become more various, and the composition become more complicated. Since there was not enough information on work and study space available, and work and study space was usually shared with other spaces and did not have a typical position and size, it is not included in this illustration. For detailed names of each space, refer to Figures 2-3 and 2-9.*

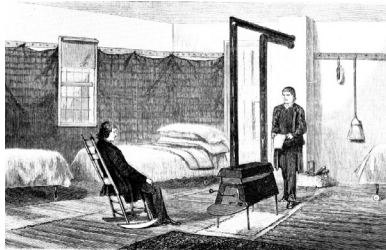


Figure 2-17. Sleeping with iron stove as the heating source. “Sleeping Room of the Men Shakers”, 1873 by J. Becker. From *Americans at Home*, by H. L. Peterson, 1971.

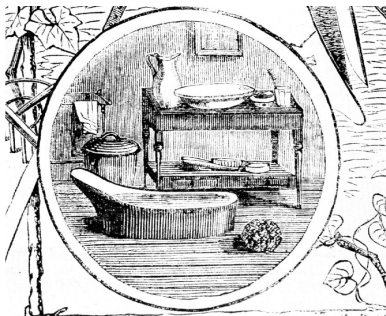


Figure 2-18. Washstand and bath tub. Woodcut from *The American Agriculturist*, May 1874. A washstand was common in bedrooms in the house without a bathroom. From *Americans at Home*, by H. L. Peterson, 1971.

## Impact of Technology

The transformation of home space obviously reflects the development of the society and the typical lifestyle. What developments had the most impact on the transformation of our home space? Based on the research, it is apparent that technology played a very important role. From one perspective, the desire of people to make life more comfortable and easier drives technology forward; on the other hand, the developed technology enriches people's life. The impact from technology is usually obvious, while the impact of people's desire has usually been ignored. This is a mutual action and reaction cycle, and both are important.

The impact of technology on home space can be considered in three aspects.

### New Energy Sources and Public Utilities

The development of new energy sources indirectly but comprehensively impacted the

home space very significantly. The open burning fire in a fireplace was the heating source in the 17th century houses. The fireplace took up a large portion of space in every heated room; it generated a center because of the warmth that made people's activities converge around it. As gas and electricity were introduced into home space, the methods of heating varied, and the importance of the fireplace became less. Today, most housing units are using a warm-air furnace, steam or hot water system, and electric heat pump for heating. These new ways of heating can heat the space evenly and require very little space. Proximity to the heating source is no longer a concern for placing furnishings, and no longer limits people's activity range.

The development of plumbing and the public sewer system is another example. Previously, water came from the well outside the house, the outdoor privy was the only option, and bathing was took place in the kitchen. Although the indoor privy appeared in the 18th century, it had to be placed in the lowest level; the toilet



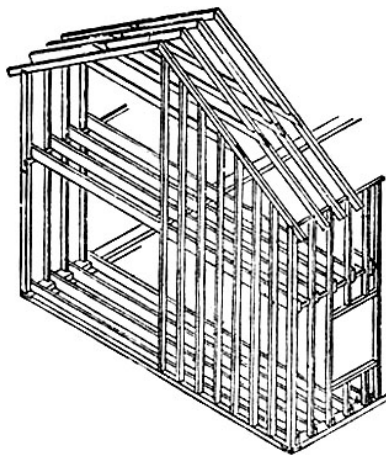


Figure 2-19. Balloon frame, isometric view. From *Carpentry Made Easy; or, the Science and Art of Framing on a New Improved System*, by W. E. Bell, 1858.

appeared in the 19th century, but it also had to be placed on the first floor; bathtubs also appeared in the 19th century, again, with the same limits. These separated spaces were able to come together to form the modern bathroom only after the plumbing and sewer system were available in the late 19th century.

### Building Technology

Old building technology limited the structure of home in both size and form. A typical 17th century house was small, square-like, with tiny windows and thick walls. The balloon system invented in the mid 19th century (see Figure 2-19) made irregular floor plans possible. Other new building and decoration materials expanded the options for the shape, form, and appearance of home space. Today, we can say, that building technology has almost removed the limitation of the structure. In planning the home space, people can now concern themselves solely with their needs and almost completely ignore any building difficulties.

### Home appliances

New inventions brought the home more appliances to make people's life easier and more comfortable. Using these new appliances adjusted new home activities. It also required transformation in the home space to accommodate them. For instance, the washing machine and dryer became commonplace, and the activities of washing and drying clothes became different. A space, such as a mud room, was added to incorporate the space requirement for both the new appliances and the new activities. TV and VCR enriched family entertainment; watching them became a typical family room activity, and the furniture arrangement in the family room was changed to accommodate this. Other similar examples include the refrigerator in the kitchen, the computer in the study area, and the furnace in the utility room.

## CHAPTER 3

# HOME SPACE IN THE 2020S

INTRODUCTION

CHAPTER 1

CHAPTER 2

CHAPTER 4

CHAPTER 5



## Overview

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Technology will continue to play an important role in the future home space.

Current research on future home space is mostly written from the technology perspective. It is valuable, but it has its limitations because of a lack of input from interior design professionals.

Lifestyles in the future will affect the activities and needs of occupants' in the future home space. Work at home, increased leisure time, continuing education, and health care will be the most important trends in next 20 years.

According to these trends, future home spaces will be transformed to facilitate these changes. Each primary space will become independent. Work and study space will become more important than ever before. Service space will have much more powerful functions and become human-free. Circulation space will provide

flexible paths to primary spaces. Activities at home will increase, with new activities added. Flexibility and variability will become new features of the future home space.

## Trends in the Future

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To create the future, as Orndoff (2001) indicated, trends are the only element that can be forecasted. Trends normally cover social, technological, economic, ecological and political topics, while some trends involve more than one topic. The predictable future home space and future lifestyle largely depend on the study of future trends. Concluded from the research on the wide range of future trends, there are four major issues that will affect lifestyle and home space in the next 20 to 30 years:

- Work at home
- Leisure time
- Continuing education
- Health care

### Work at Home

According to the Bureau of Labor Statistics (as cited in Challenger, 2000), only 15% of the civilian labor worked flexible schedules in 1991. From the same survey conducted again in 1997, this data showed a significant increase to 27%.

According to the survey conducted by American Demographics in 2000, 79% of workers chose "having a work schedule that allows time with my family" to be the most important part of a good job (as cited in Orndoff, 2001).

A survey by Challenger (2000) repeats this, 43% of human-resource executives said that an increasing mobile, telecommuting work force would be the biggest workplace trend in the 21st century. This concept is driven by employee demand for a more flexible schedule, and more time with family, since telecommuting helps to realize this goal.

On the one hand, technology will allow laborers to focus much more on interpersonal roles, the human side of work. On the other hand, technology will ensure powerful communication between the home space and the work place. Besides the obvious benefits to employees, society will also benefit from reduced commuting and lower stress.

Halal, Kull, and Leffmann (1997) predicted that 80% of employees will work partially from remote locations in 2020. The home space is probably the most important remote location for work.

### **Increasing Leisure Time**

The workweek is continuously decreasing by work hours. The work load has been reduced by technology especially on labor work. The average workweek was 39.2 hours in 1996 according to Molitor (1998, p 59), and it will likely decrease to 30 to 35 hours by 2030.

Holidays and vacation days will increase. With the extra time saved from working, people may possibly devote over 50% of their lifetime to entertainment, hospitality, and recreation by 2010. Indeed, Molitor (1999) predicted, the next era before 2015 will be a leisure era.

### **Continuing Education**

We live in an information era where human knowledge is increasing in a fast rate. The whole body of the world's scientific knowledge doubles every 10 years (Kraegez, 1978, as cited in Smith, 1979). With this rate of increase, the knowledge-base of a college graduate will only count less than 7% when he/she reaches his/her 60s. This means that as much as 93% or more knowledge will be new to this person, if he does not continue to acquire new knowledge skills.

On the other hand, technology brings a new way of education. Pearson (2000) predicted that in 2020, education opportunities will grow wider

with the virtual classroom. Education will not be confined to a single school or a certain age. Students will be able to learn by using interactive computerized programs over the Internet from home.

Continuing education will become a fixed part of life. Being educated for new knowledge will become a more important activity at home.

### **Health Care**

The American Association of Retired Persons estimated that by 2010, there will be nearly 40 million people over the age of 65, and more than 69 million by 2030 (Wardell, 2000). With the aging society, the importance of health care increases. By 2033, around 20% of Gross Domestic Product (GDP) will be devoted to health care (Molitor, 1998). Along with that, health care devices will be widely used at home. According to Kerzweil (1999), computerized health monitors will become very small and can

be embedded with ease at home to provide diagnoses, treatments, and interventions.

## Future Technologies around Home Space

Technology will be a major factor in the shaping of home space. As to how the transformation of home space reflects the impact and development of technology, the current study and prediction on future technologies offers some ideas of the future home.

### Technologies that Focus on Home

Today many researchers focus on the whole body of future home space. Home automation is one of the most pervasive topics.

Home automation, as defined by The Home Automation and Networking Association, is "a process or system (using different methods or equipment) which provides the ability to enhance one's life style, and make a home more comfortable, safe and efficient" (The Home Automation and Networking Association, 2001).

The key concept of home automation is installing and wiring electronic devices to the lighting, heating, air-conditioning, telecommunications,

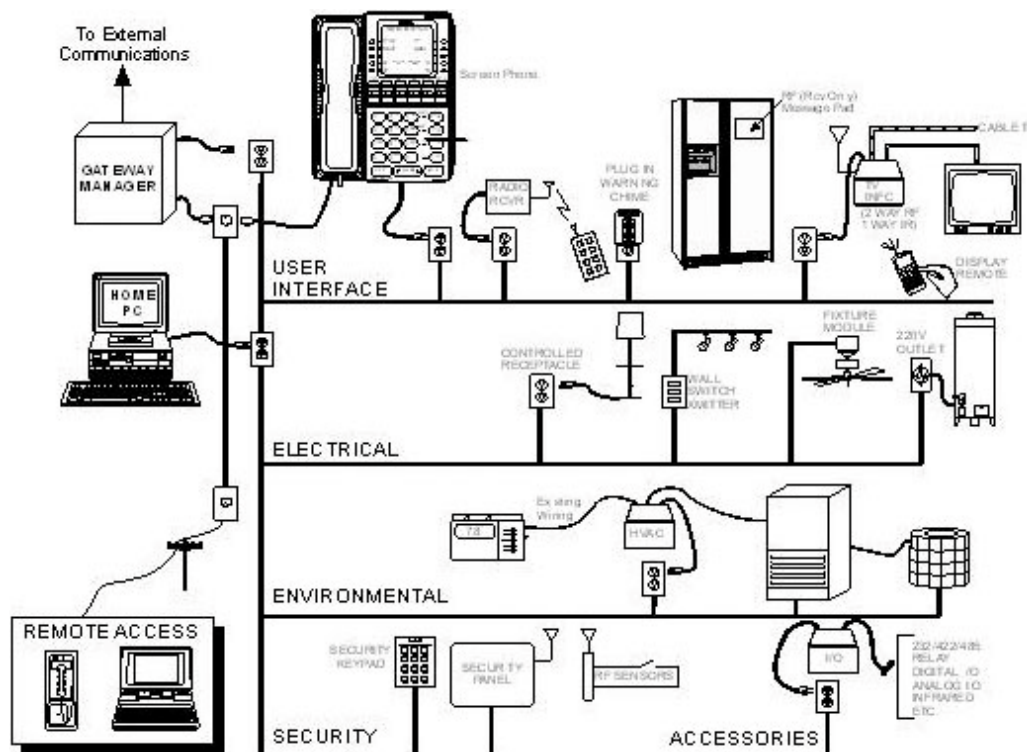
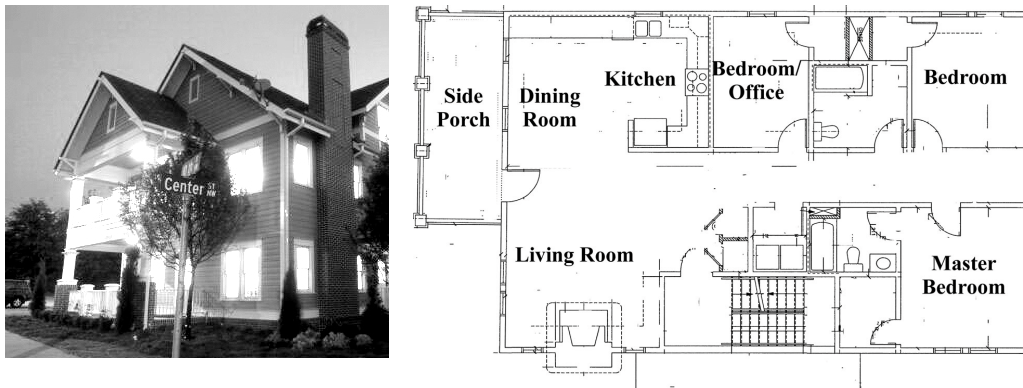


Figure 3-1. Concept for Home Automation: "Next generation system of smart house". From: "Advanced Interfaces Overview", by M. Cogbill, 1998.

and security systems in the home, and linking them to a central control system as well as outside network. By doing so, occupants can track and direct everything that happens in the home space with remote controls, such as to open or close doors, turn on or off lights, or adjust room temperatures. Furthermore, occupants can program the system to do routing things automatically according to occupants' activities.



*Figure 3-2. Aware Home by BIRL of Georgia Institute of Technology. Left: Outside view; Right: First floor plan. From the perspective of home automation, there is no changing in the structure and interior spaces of house, which reflects the needs and activities of occupants in the future. From: Aware Home Research Initiative (AHRI), 2000.*

Similarly, Wiring America's Homes is another organization that works on the concept of integrated wiring by putting entertainment, communications and security systems together.

In 1995, Broadband Institute Residential Laboratory (BIRL) of the Georgia Institute of Technology wired a three-story house called Aware Home, with broadband technology to study how technology affects and enhances home life. Nearly 500 sensors from pressure-sensitive floor tiles to ceiling cameras and hidden microphones were installed throughout the house to monitor resident's daily activities. The computer that linked all these sensors was programmed to better understand what people were doing and what people wanted to do.

According to the survey data from Parks Associates (as cited in Kirschner, 2000), in 2000, 250,000 homes in the United States were wired for home automation. There will be an estimated 34 million wired automated homes in the United States in 2004.

These studies illustrate some possible impacts on the future home. However, they only reflect the direct impact of technology on home space. From the perspective of interior design, other issues should be seriously considered, as noted below.

- The fuller implications of future lifestyle and activities should be imagined and studied further.
- The technology impact on a larger scope, such as the interior space and the building structure, should be incorporated.
- Other technologies, such as fuel, material, transportation, etc., will significantly impact the whole future society and should be included.

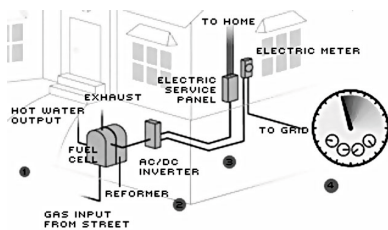


Figure 3-3. The working process of the fuel cells. From: *"Dreams of The New Power Grid"*, by C. Wardell, 2000.

## Other Technologies

Other technologies, which may not directly focus on home space, or may only focus only on a specific area, are also important in forecasting the future home space. These technologies include three general groups: energy and utilities, new materials, and appliances and devices.

## Energy and Utilities

Energy and utilities are the power that keep a home space running.

- **Alternative Energy.** Varieties of alternative energy sources will be available in the near future. By 2020, nuclear power will become a commercially viable and cheap source of energy (Molitor, 1998). It will become half of the electricity generated in 2020 (Halal, Kull, and Leffmann, 1997).
- **Fuel Cell.** Clean-burning fuel cells installed in the basement will provide

power to the future home by generating electricity from its chemical interaction of oxygen from the air and stored hydrogen (Wardell, 2000, see Figure 3-3). The first gasoline-to-electricity fuel cell was demonstrated by Plug Power in New York in 1997 ([www.plugpower.com](http://www.plugpower.com)). Predicted by Halal, Kull, and Leffmann (1997), fuel cell will be in common use by 30% of the American homes in 2017.

### New Materials

New materials will be invented to replace traditional materials.

- **Electrochromic Glass.** This kind of glass has alternative transparency, which can be controlled to change color, and transparency, so that people can easily adjust it to control the amount of heat, or light, or block the view for privacy (see Figure 3-4). At least three companies are developing prototypes that may be available soon (Wardell, 2000).

- **Virtual Window.** Pearson (2000) predicted that by 2015, windows may be replaced by screens, which offer occupants the opportunity to choose what they want to see from the window.
- **Smart materials.** Millett and Kopp (1996) indicated that in the near future, smart materials with electronic sensors in their molecular structures will be able to respond to stress by sending out signals or changing color; and these materials will become cheap enough to be used in homes. Salzman and Matathia (1998) also predicted that high-tech fabrics will be used as wallpapers that have the ability to turn every flat surface into a screen to display anything.

### Appliances and Devices

New appliances and devices will appear in the future home space and directly affect it.

- **Computers.** Kurzweil (1999) predicted that in 2019, computers will become



Figure 3-4. Electrochromic Glass that can adjust the color and transparency. From: "Electrochromic glass", 2002.





Figure 3-6. Tomorrow's laptop on a roll. Designed by IDEO ([www.ideo.com](http://www.ideo.com)). From: "Welcome to 2010", 2000.



Figure 3-5. Volumetric 3-D Display by "The Perspecta Spatial 3D Visualization Platform". From: Actuality Systems, 2002.

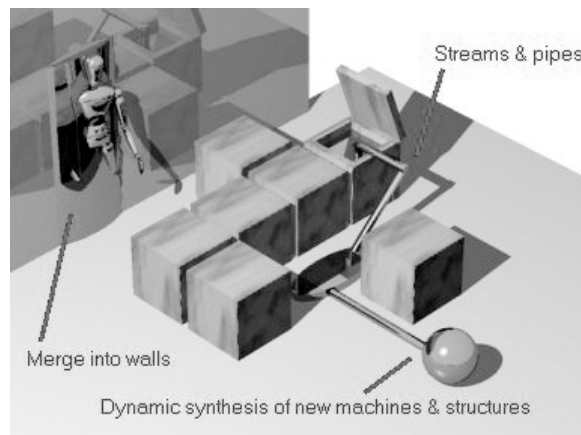


Figure 3-7. Concept for Fractal Robot. From: Fractal Robots, 2000.

small enough to embed everywhere in a building, furnishings, clothes and the human body.

- **3D Display.** The first volumetric 3D display system was developed in 2002 by Actuality Systems ([www.actuality-systems.com](http://www.actuality-systems.com)). People can walk around to see the 3D image without wearing glasses (see Figure 3-5).
- **Robots.** According to Pearson (2000), by 2020, some mobile computers - robots will be used for all manner of jobs around the home. According to Fractal Robots (2000), by 2020, the fractal shape-changing robots will be small and powerful enough to be used for furnishing. The product made with Fractal Robots will be able to produce any texture, color, and feel.

## Home Space in the 2020s

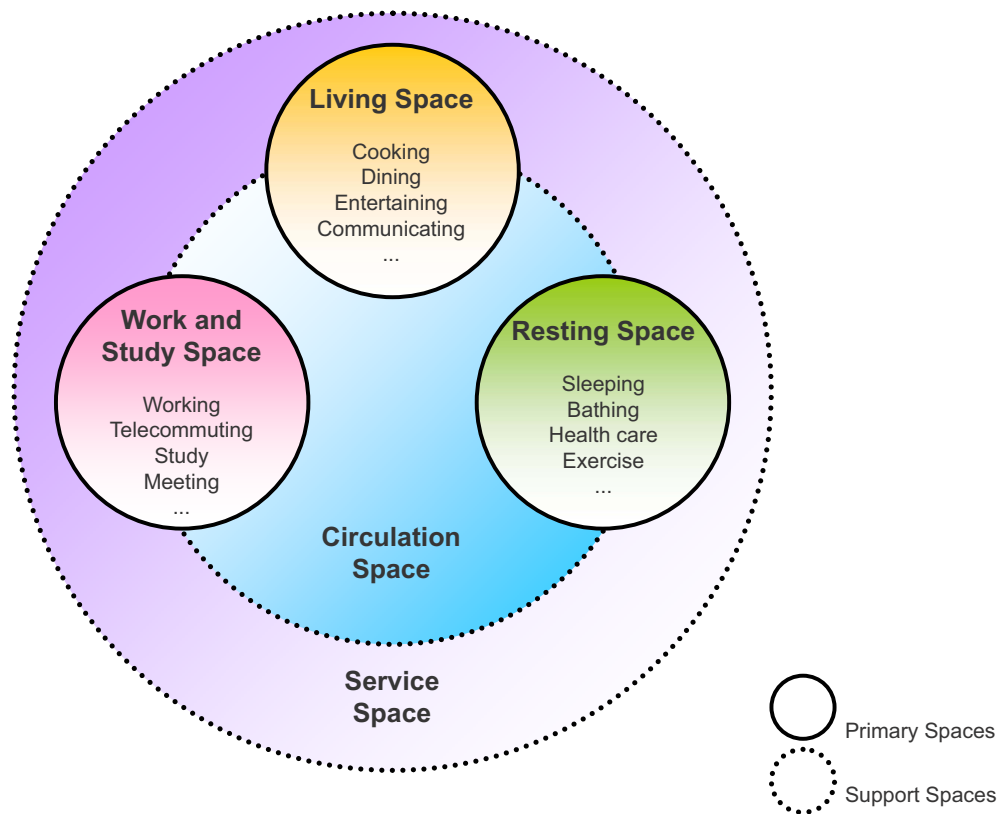


Figure 3-8. Relationships of home spaces in the 2020s.

Technology will impact our lifestyle in the future; it also will provide appliances to improve our life quality and meet our needs.

To accommodate the future trends that affect lifestyle, and to reflect the possible development of future technology, all areas of the home space will have changes. Generally, the future home space will have major differences in three ways:

- Every individual space/room/area on the primary spaces, will physically exist closer, and form a group of space, which relatively separates from other home spaces. Service space will become human-free, operated with powerful technological functions. Circulation space will serve only primary spaces (see Figure 3-8).
- Future home space will be able to accommodate more activities. Un-typical activities to today's home space will become typical activities for the future home space, such as work and study;

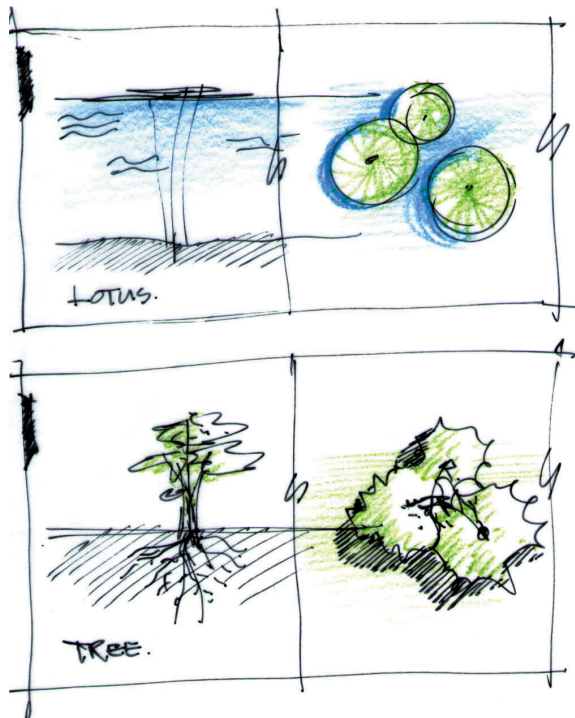


Figure 3-9. Inspiration from nature. Each space is an individual one, but links together as a whole. Relationships among the individual spaces are flexible and dynamic.

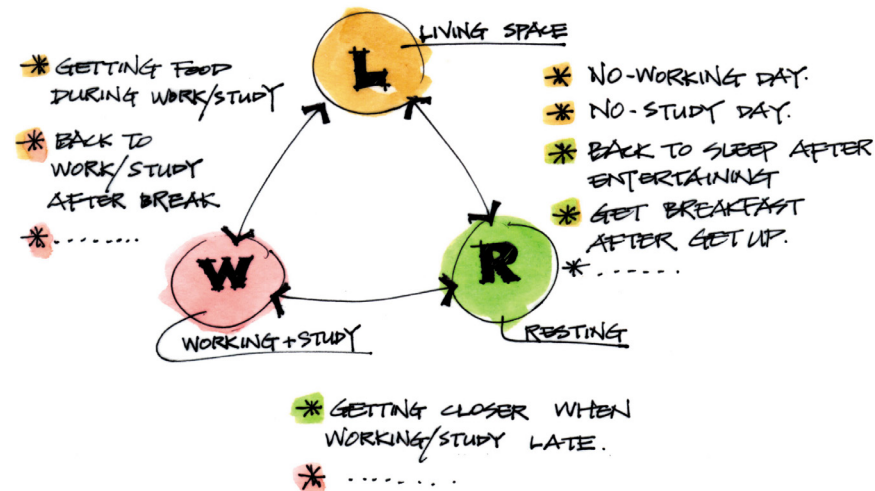


Figure 3-10. Occupants may have different needs according to their activities and time. The relationships among primary spaces should be flexible to meet the needs.



Figure 3-11. People will be able to meet others within an all-enveloping tactile environment. From “Spiritual Machines: The merging of man and machine”, *The Futurist*, by R. Kurzweil, 1999.

## Living Space

There will be three major changes in the future living space.

First, the entertainment activities will increase. Since leisure time will probably increase to 50% of people’s life time by 2015 (Molitor, 1998), people will most likely spend more leisure time at home. And, they will most probably spend this time in the living space. The trend is already happening today in home spaces. Color TV, cable/satellite dish antennas, VCR/DVD players, and stereo systems have already become commonplace in most homes (refer to Figure 1-1). Visual reality, and home theater systems, as well as 3D display, will add to and enrich home entertaining in the near future. Entertainment via technology will become a major activity in the future living space.

Secondly, the traditional guest receiving area will become less important in the future. In today’s home space, the living room is primarily for

guest receiving. According to Kurzweil (1999), by 2019, the all-enveloping tactile environment will become widely available and fully convincing. It will provide a resolution that equals or exceeds human touch and that can simulate (and stimulate) all of facets of the tactile senses, including the sensing of pressure, temperature, textures, and moistness. This means that people will not necessary meet guests physically in the living space. The chances of using living space to perform the traditional guest receiving activity may actually decrease.

Thirdly, the size and form of the living space will become resizable and flexible. As predicted by Pliny Fisk (2000), co-director of the Center for Maximum Potential Building Systems, the house in 2025 will be "constructed of flexible and regionally based parts, it will be expanded and deconstructed as space requirements change" (as cited in Sinha, 2000, p. 66). This will be especially true in the living space because it has more activity types than other spaces. Additionally, the size of it may be reduced in

order to be energy-effective: as more activities are needed, the living space will expand to accommodate the needs. Resizeability and flexibility will become important features of the future living space.



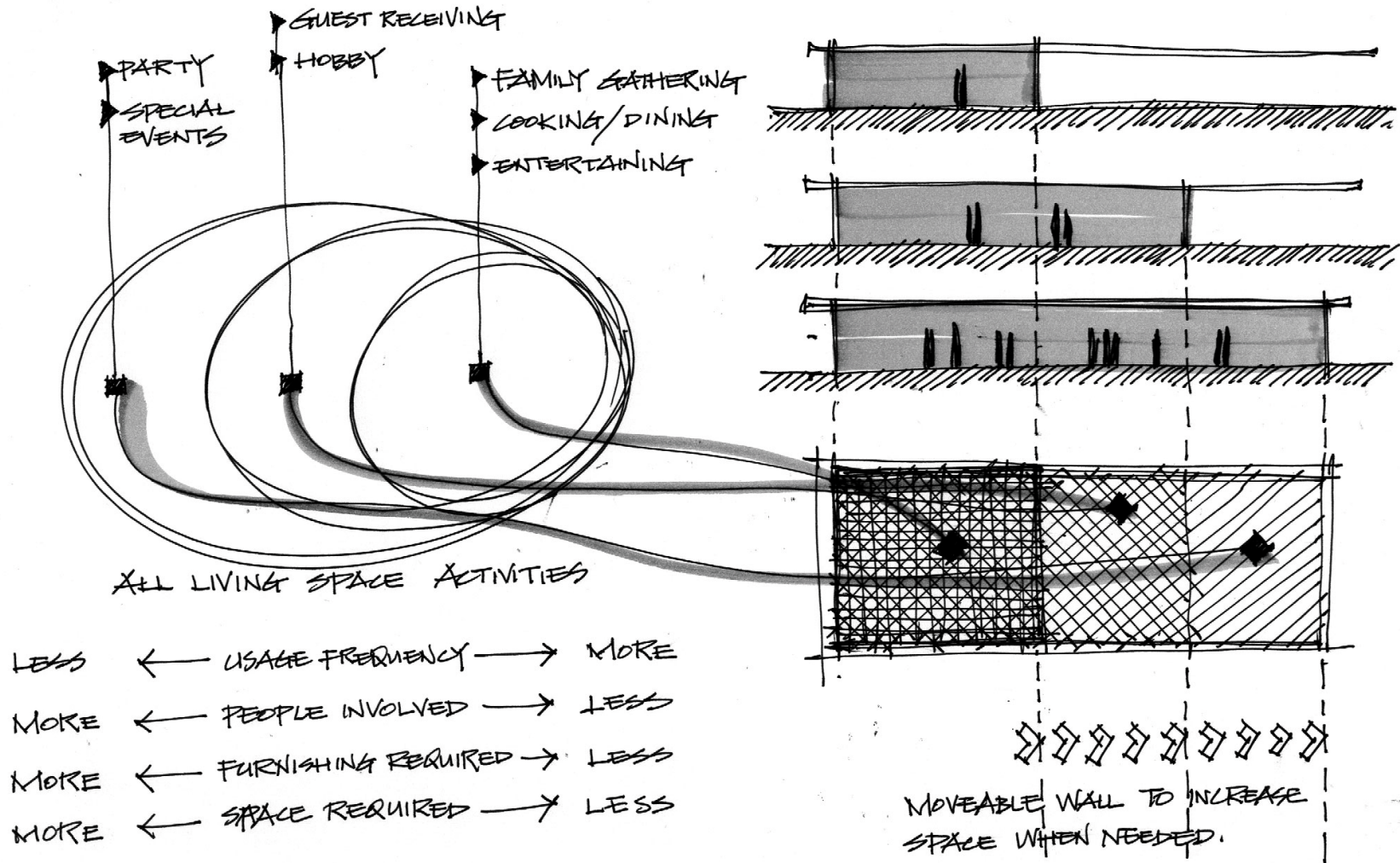


Figure 3-12. Concepts for a resizable living space.

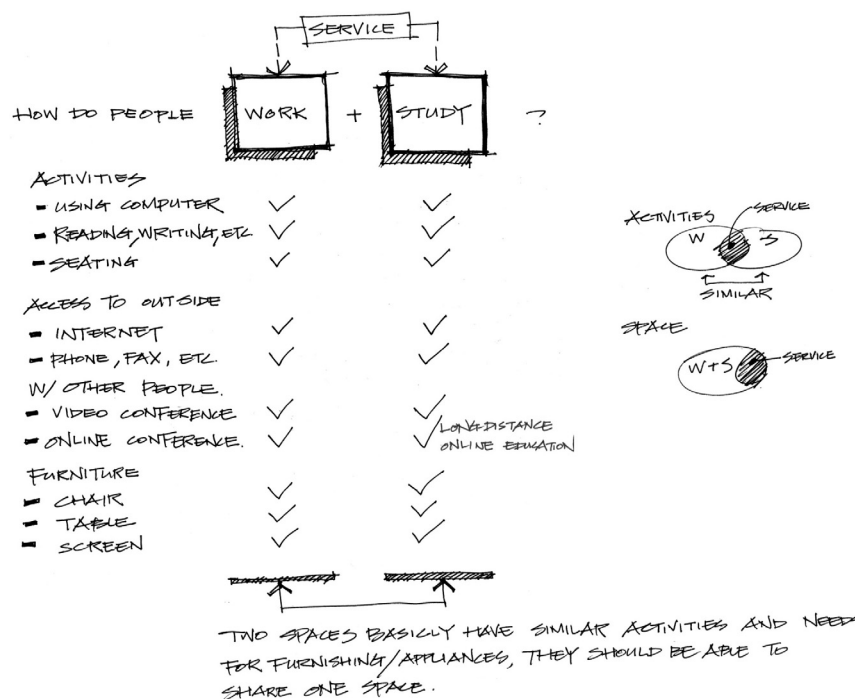


Figure 3-13. Work and study should be able to happen in one place with the same furnishings.

### Work and Study Space

Work and study space in the future will have two major trends.

First, this space will become a stand-alone and larger space in the future home. Today in most homes, work and study space is not as important as other primary spaces. It is usually small, and has to share space or time

with other spaces, such as a spare bedroom, formal dining room, basement, and/or garage, etc. Magee's (1999) addressed that in today's homes, the first reason that people choose where to locate their place for work is the availability. Since work at home will become a future trend and technology will provide more possibilities for people to work from home in the near future, work as a necessary activity will require a larger space and a separate location.

Secondly, personal study will become another necessary activity in this space. As the whole body of world knowledge increases at a fast speed, continuing education will be required for everyone. Because future technology will be able to provide reliable communications for people to study from remote locations, people will be able to receive education at home by sharing the communication system for work. Also, because learning and working have similar space and furnishing requirements, personal study space will share the space with working space.

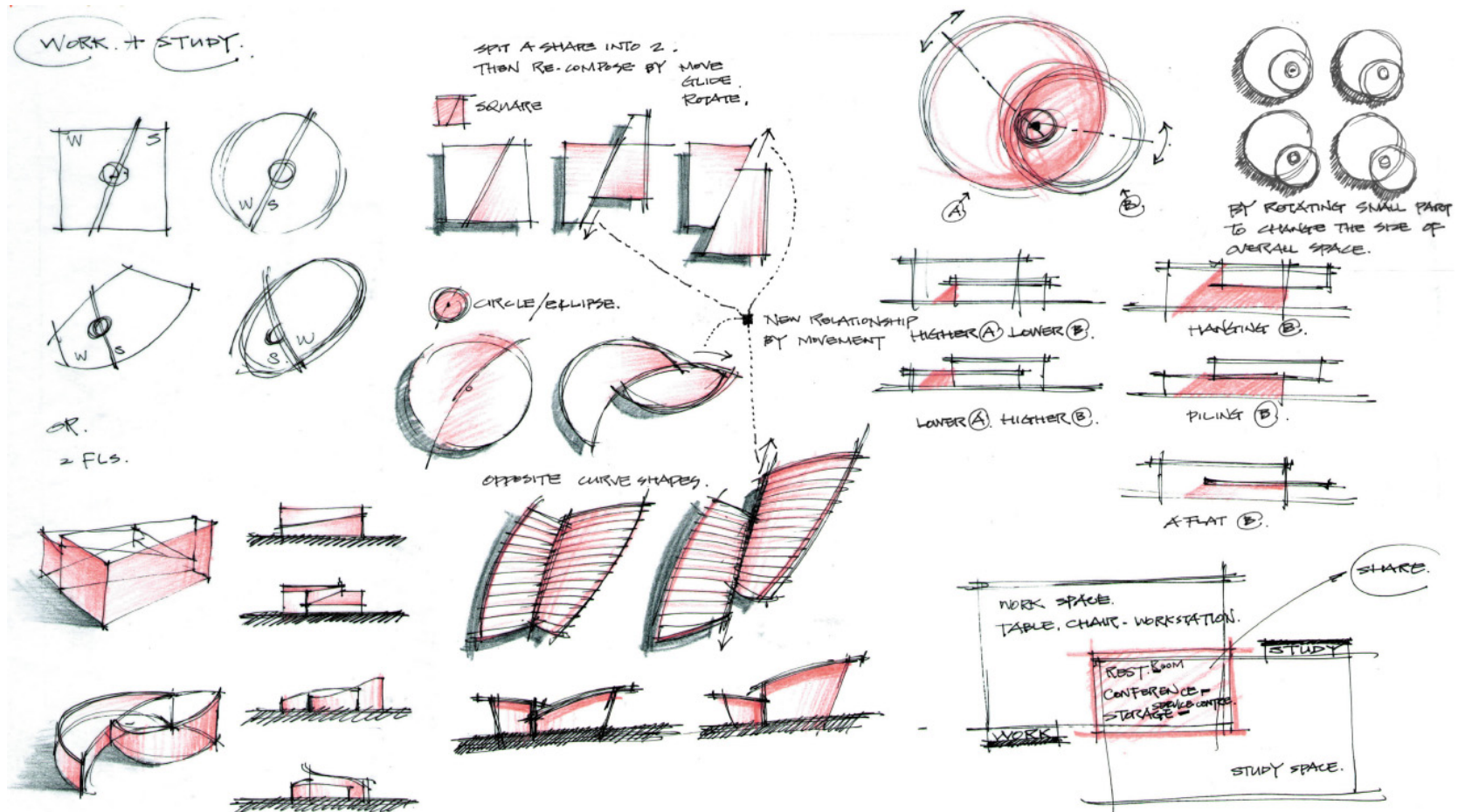


Figure 3-14. Ideas for a joint work and study space.



## Resting Space

Resting space in the future home will have the ability to incorporate new activities and new functions.

First, health care as an important activity will be added to the resting space. With a growing senior population, health care will be more important than today. Many health care devices will be available for home use in the near future.

For instance, predicted by Pearson (2000), a health and hygiene body station that can scan and monitor human body and vital signs will likely be available by 2020 (see Figure 3-11). For privacy reasons, the resting space will be the best place for activities using health care devices. These new devices will locate in existing bathrooms with new functions, or appear in a new separate area in the resting space. In the “Pioneering Survey” by the International Furnishings and Design Association (IFDA), 82% of respondents expected health or exercise centers in a home design in 2020

(IFDA, 2000).

Secondly, entertainment and automation will be introduced into the resting space. Philips Electronics (1996) has designed a prototype named Bedroom Heart that will be able to do the above things. Salzman and Matathia (1998) predicted a fully automated bedroom “allowing us to control lights, phones, drapes, alarms, media units, climate, etc.” (p. 53). Today’s resting space will expand into entertainment activities and the control of all entertainment and other services will be much easier.

Thirdly, the closet and the storage space in the future will be very different from the ones today. The future closet will be able to provide suggestion and 3D display that helps people select clothes. With the more powerful functions of the service space, the storage function of the closet will be provided by the service space through the service center. Choosing and storing will become much easier with the help of technology (see Figure 3-12).



Figure 3-15. Prototype of health monitor which will be available by 2020. From “The next 20 years in technology”, *The Futurist*, by I. Pearson, 2000.

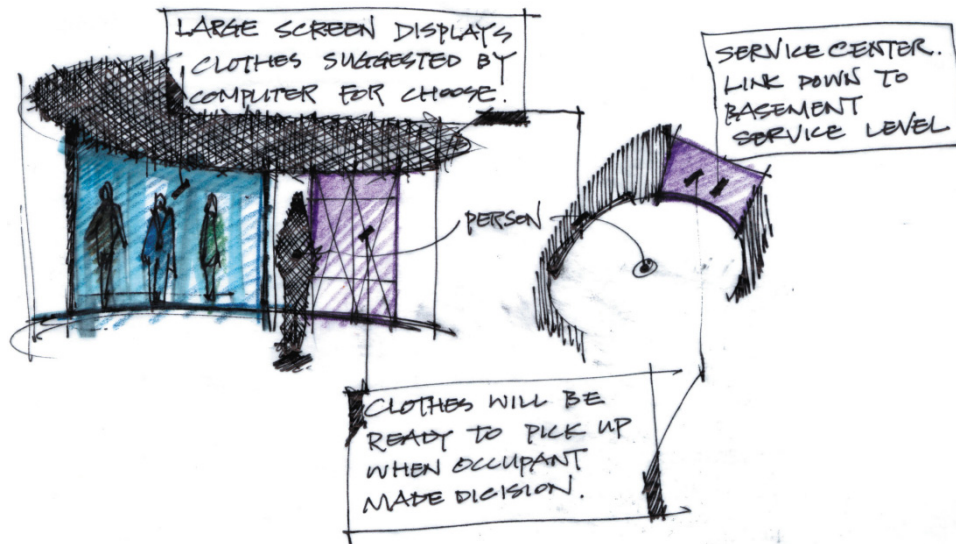


Figure 3-16. Ideas for the future closet.

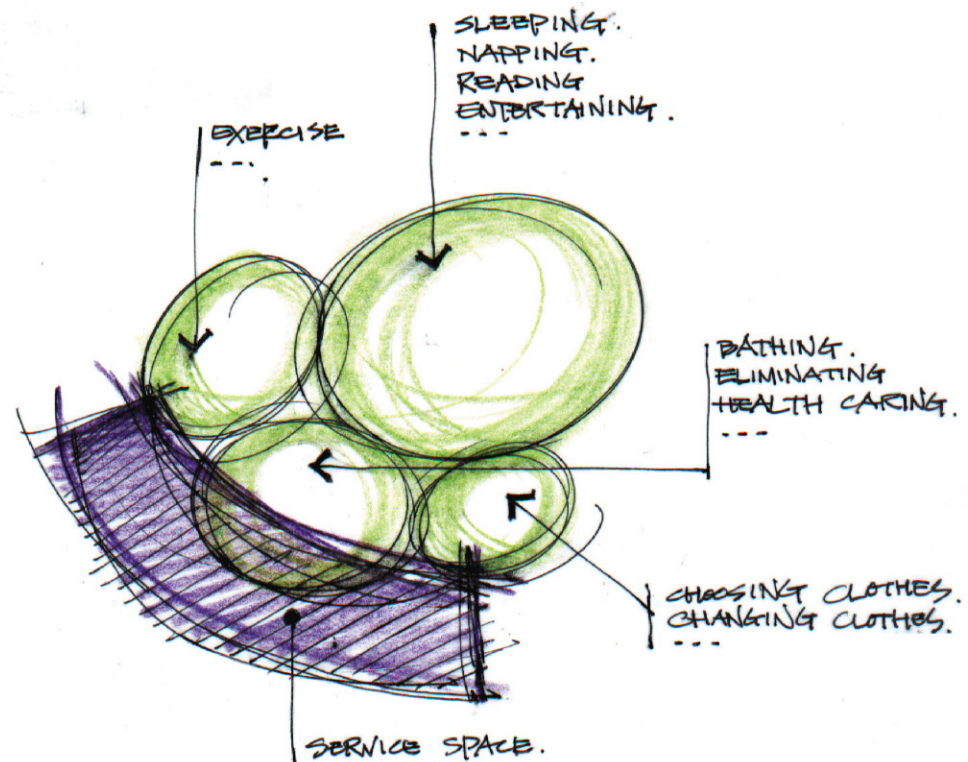


Figure 3-17. Groups of activities in the resting space.

## Service Space

Home automation will give people more remote control. This technology releases people from physically doing service activities in service spaces. This idea is already in place today in some homes. Since the service space may be able to function by remote control, or even by automated robotics, the need for people to physically be present in the service space will become unnecessary in the future. Service space will possibly be a human-free home space.

Service space will largely change the meaning of service and the form of storage space. Because this space will not be designed for human access, and in order to better provide service to primary spaces, service space possibly will be located underground and underneath all three primary spaces. The links that connect service space and primary spaces will be vertical and cylinder-like. The interface that appears in the primary space will be the service center. It will

allow people to put everything that needs service - store, clean, organize, or dispose - to it. The service center will perform the desired operation on the basement level. For instance, people's clothes will be taken care of by the service center in the following steps:

1. Service center collects clothes through the interface as a laundry basket.
2. Service center transfers the clothes to the washing and drying areas in the basement level.
3. Clothes have been cleaned, organized, and stored in the basement level.
4. Dressing room provides dress suggestions by using computer and display screen.
5. Service center transfers the selected clothes to people through the interface as a wardrobe.

All these steps in the service space will be automated or remotely controlled (see Figure 3-16).

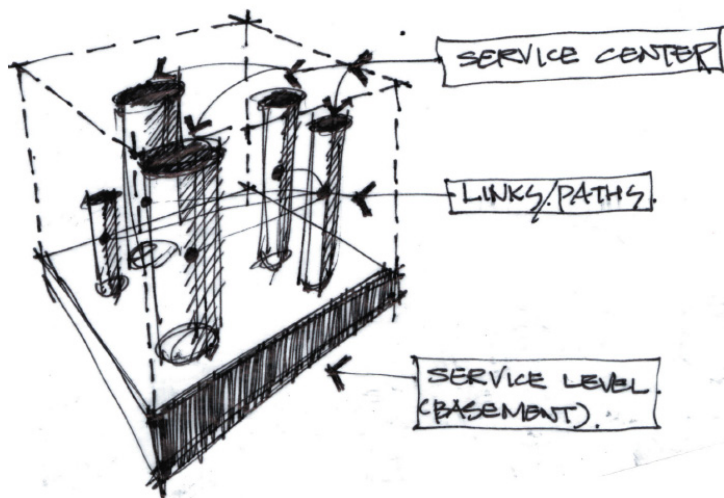


Figure 3-18. Service center.

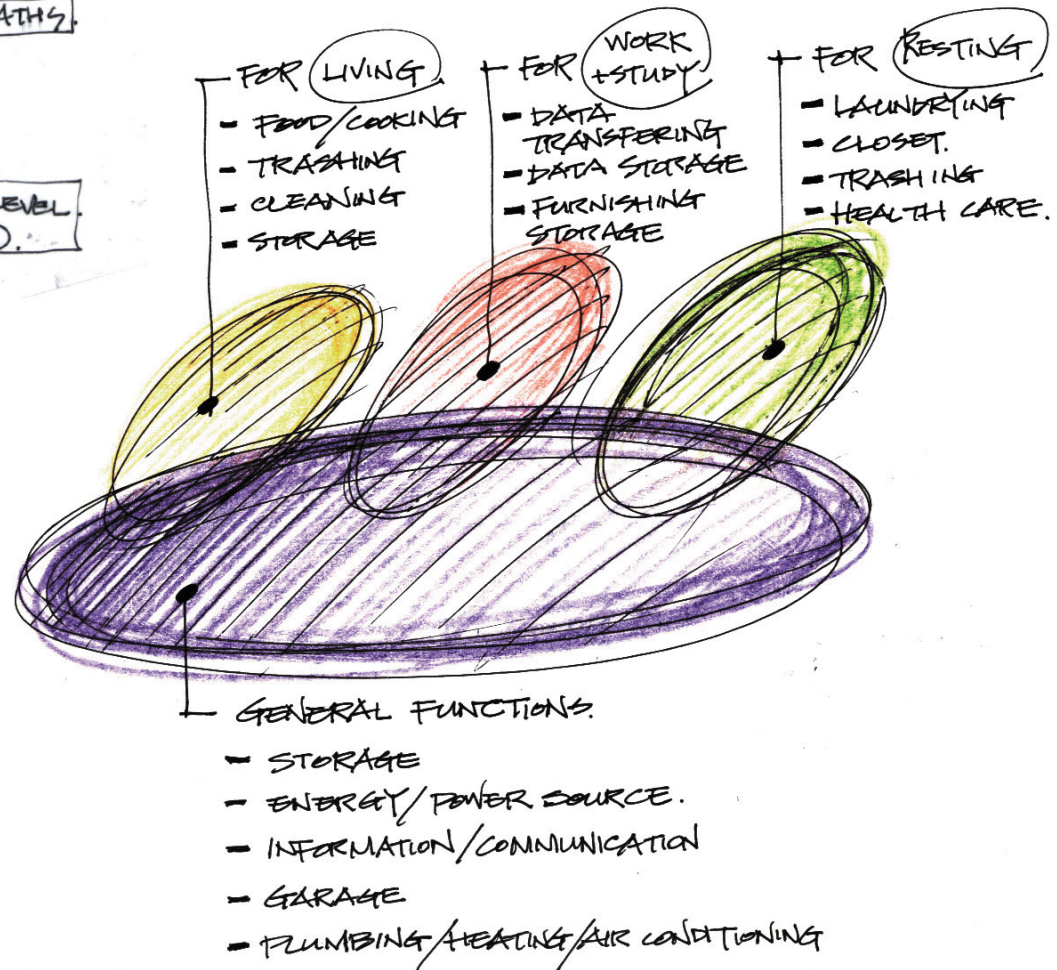
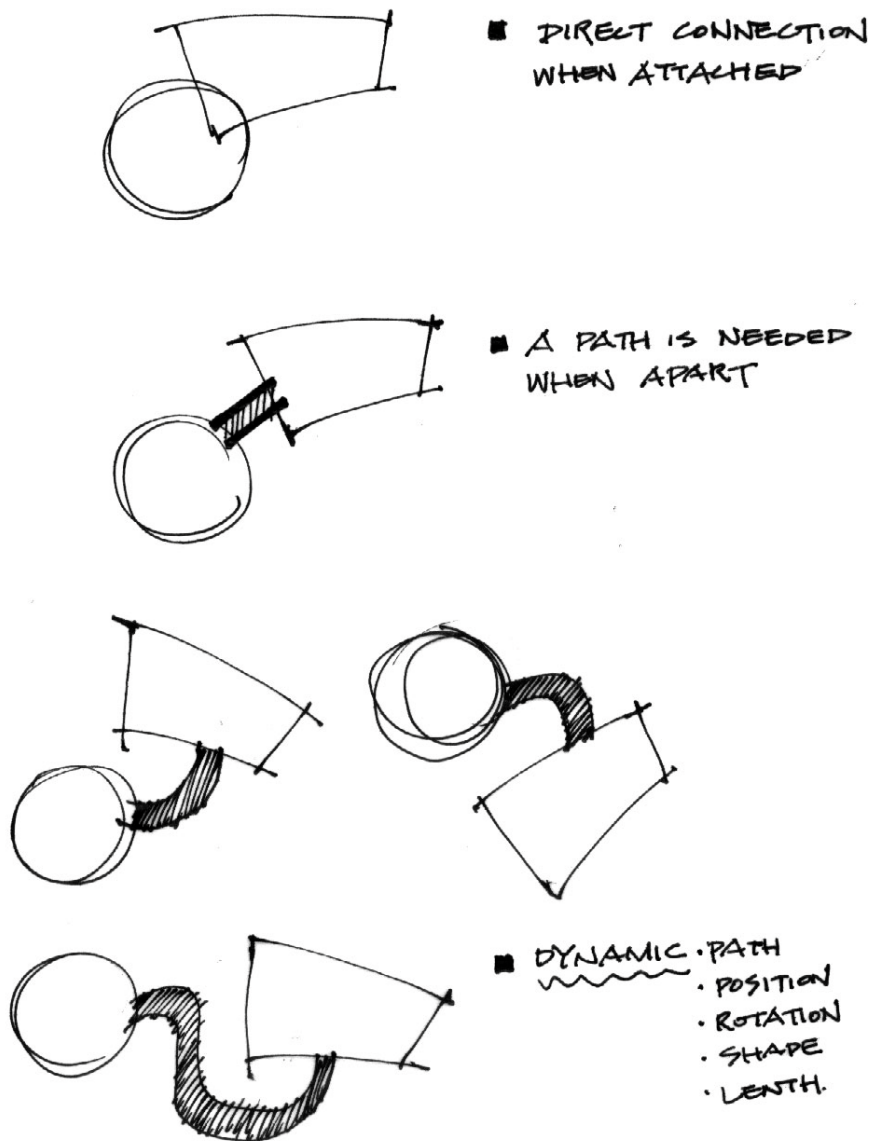


Figure 3-19. Groups of functions in the service space.



### Circulation Space

Circulation space provides convenient paths to link all other spaces. Since the service space will possibly become a human-free space, the paths between the service space and primary spaces will become vertical links to support service for people. Because of this, circulation space will only provide paths for three primary spaces in the future. In order to accommodate the dynamic and flexible features of the primary spaces, the circulation space will also have the same features. The form, size, and even position will be able to change according to the needs.

Figure 3-20. Different positions of primary spaces require dynamic circulation.



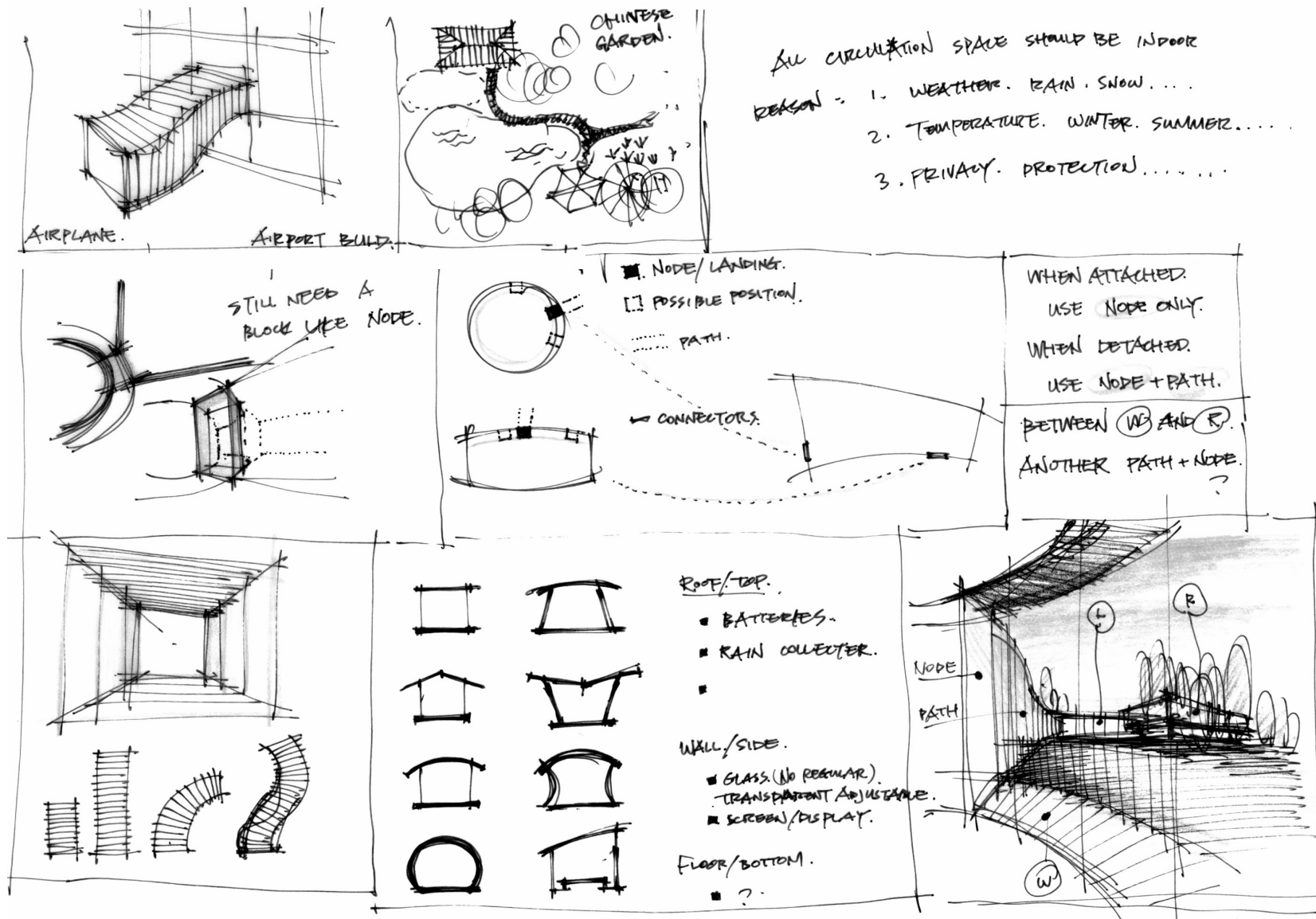


Figure 3-21. Flexibility and variation of the circulation space.

## CHAPTER 4

# MIDDLE-CLASS SOLUTIONS

INTRODUCTION

CHAPTER 1

CHAPTER 2

CHAPTER 3

CHAPTER 5

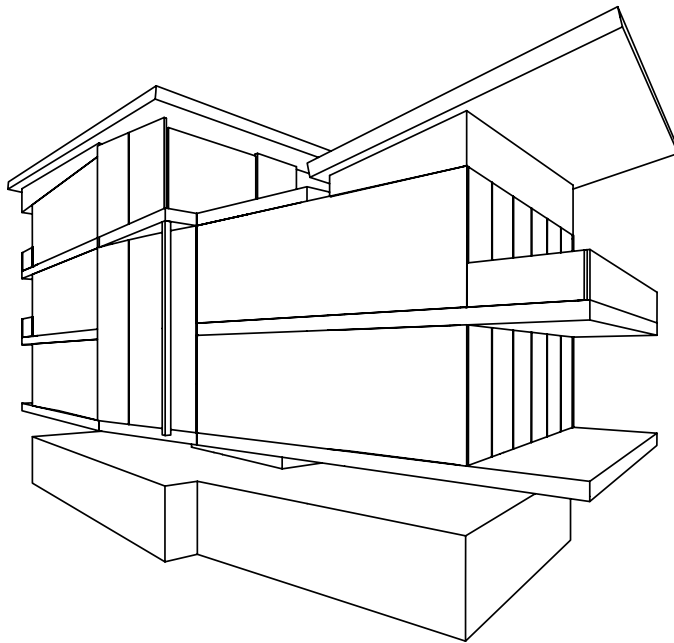


Figure 4-1. Study model for a typical middle-class house.

This prototype is designed for most average middle-class occupants. Molitor (1998) stated that in 2020, the average family will have 2.35 people, and the size of the house will be around 2,600 square foot. Baker (1996) also predicted that there will be more two-person households by 2015.

This house is a detached house that has three stories and an underground service level. The typical size of this house is 2,600 square feet, but it can be expanded up to 2,900 square feet.

The entire space construction of this house represents possible changes in the future that vary from today's standard.



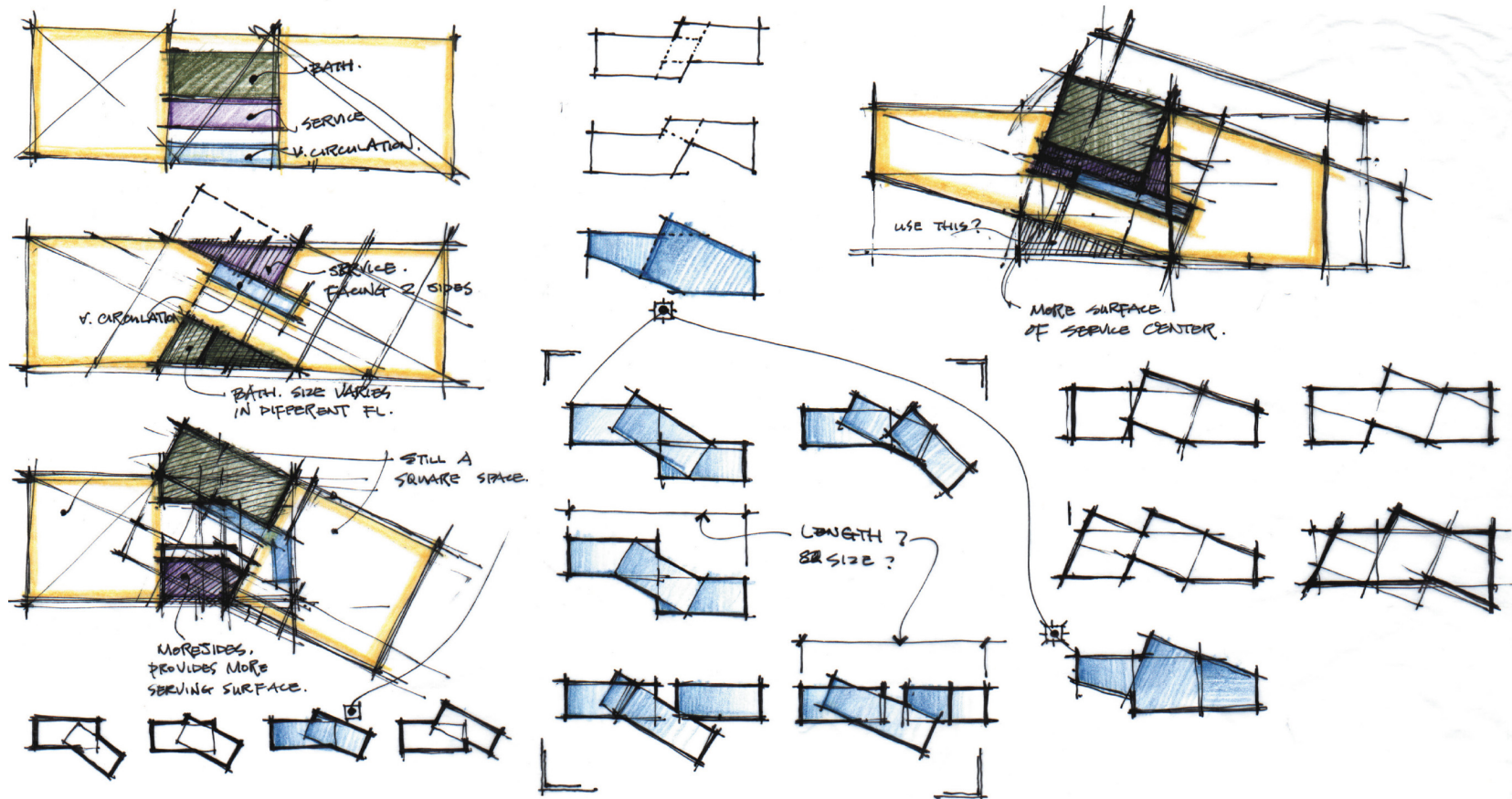


Figure 4-2. Conceptual ideas for a typical middle-class house.

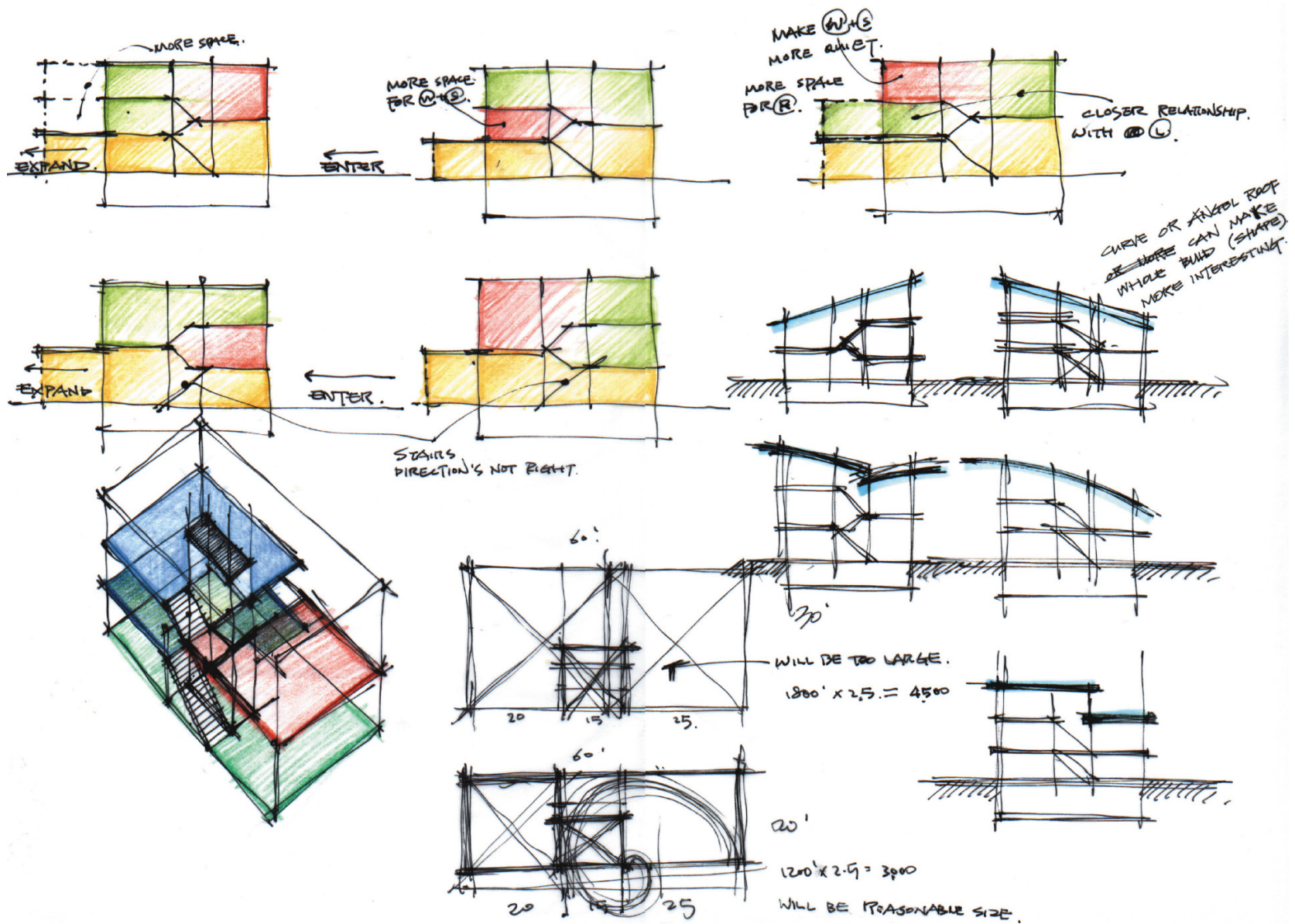


Figure 4-3. Thinking process - primary spaces compositions, sections.

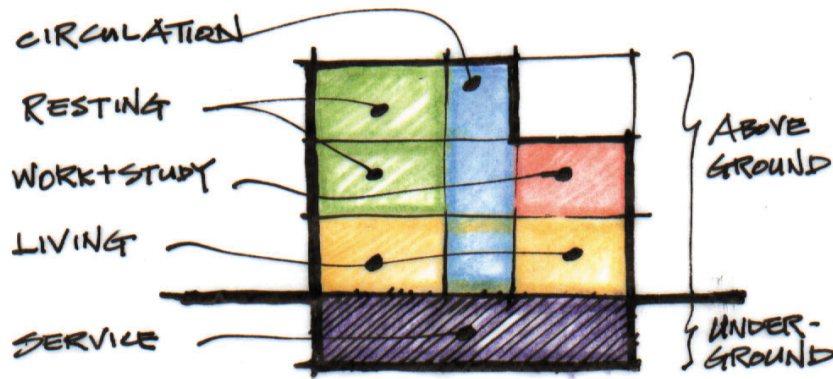


Figure 4-4. Components from the vertical view.

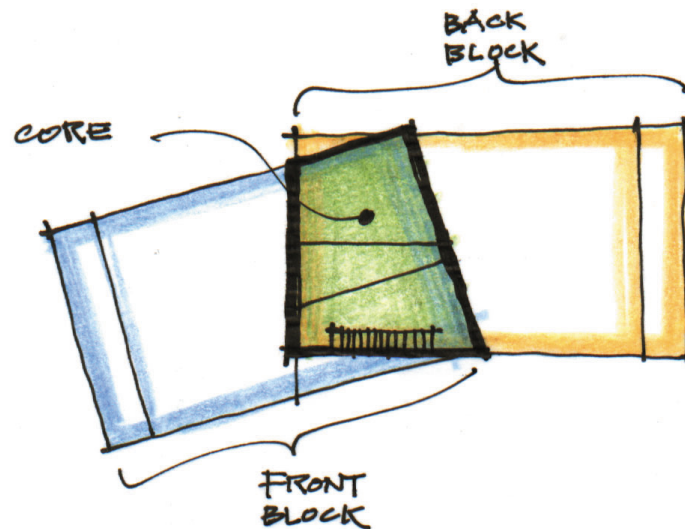


Figure 4-5. Components from the plan view.

From the vertical view, this house has two parts. A three-story construction above ground contains primary spaces, which are living space, work and study space, and resting space; and the circulation space. The other part is an underground level, used for the service space (see Figure 4-4).

From the plan view, this house has three parts from the front to the back. The front and back part is contains three primary spaces. The core part mainly includes the circulation space and the service center that require vertical connections. This part also contains the bathroom area and the kitchen area (see Figure 4-5).



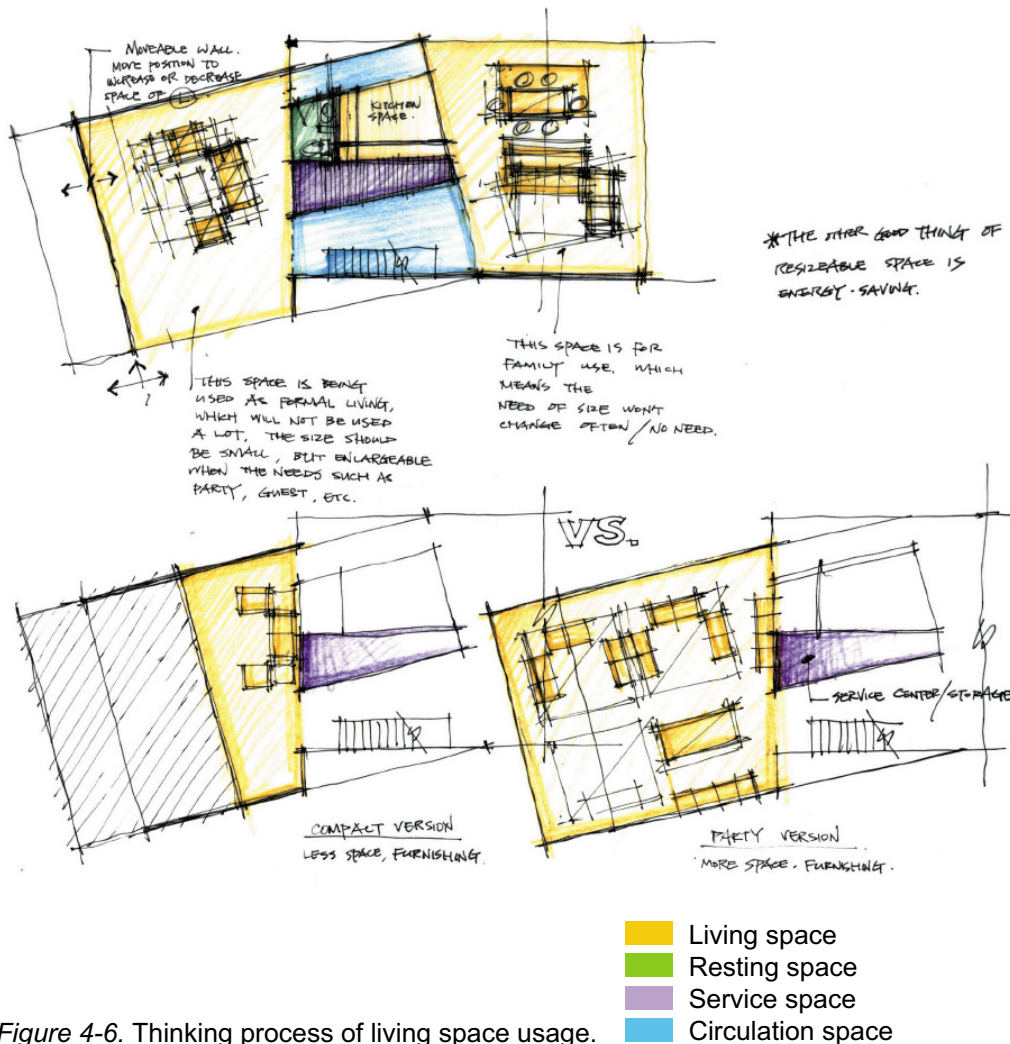


Figure 4-6. Thinking process of living space usage.

The first floor is the living space. The front part is mainly for formal guest receiving. It has the simplest furnishings and smallest size. However, when more space is needed, this space can expand, and the furnishings will accommodate the change to meet the need (see Figure 4-6).

The back part is for family use, which includes living activities, cooking, dining, and entertaining. The entertaining activities can expand to the extra space in the front part. Location in the back gives the family activities more privacy. A half bathroom is provided on the first floor.

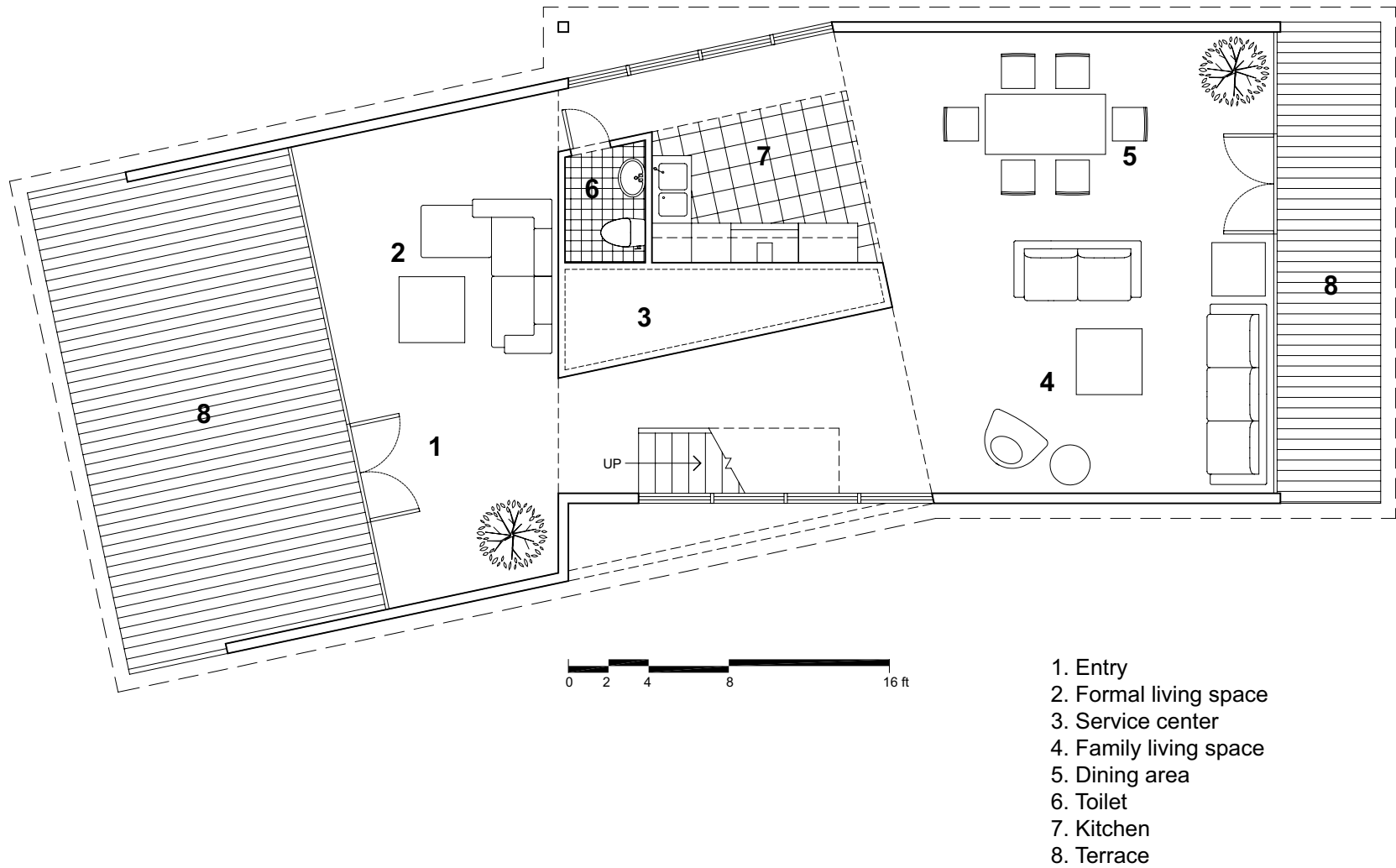
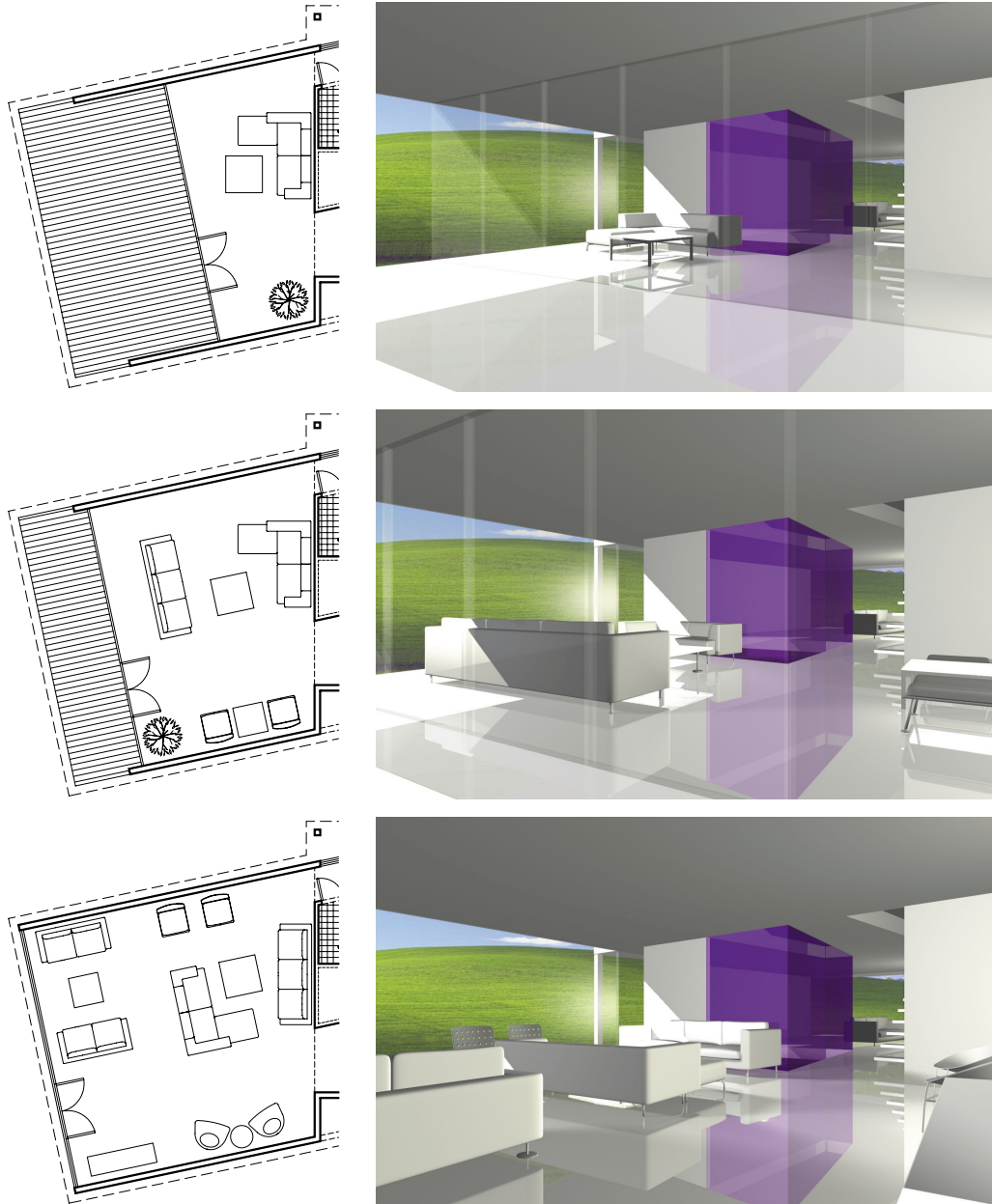
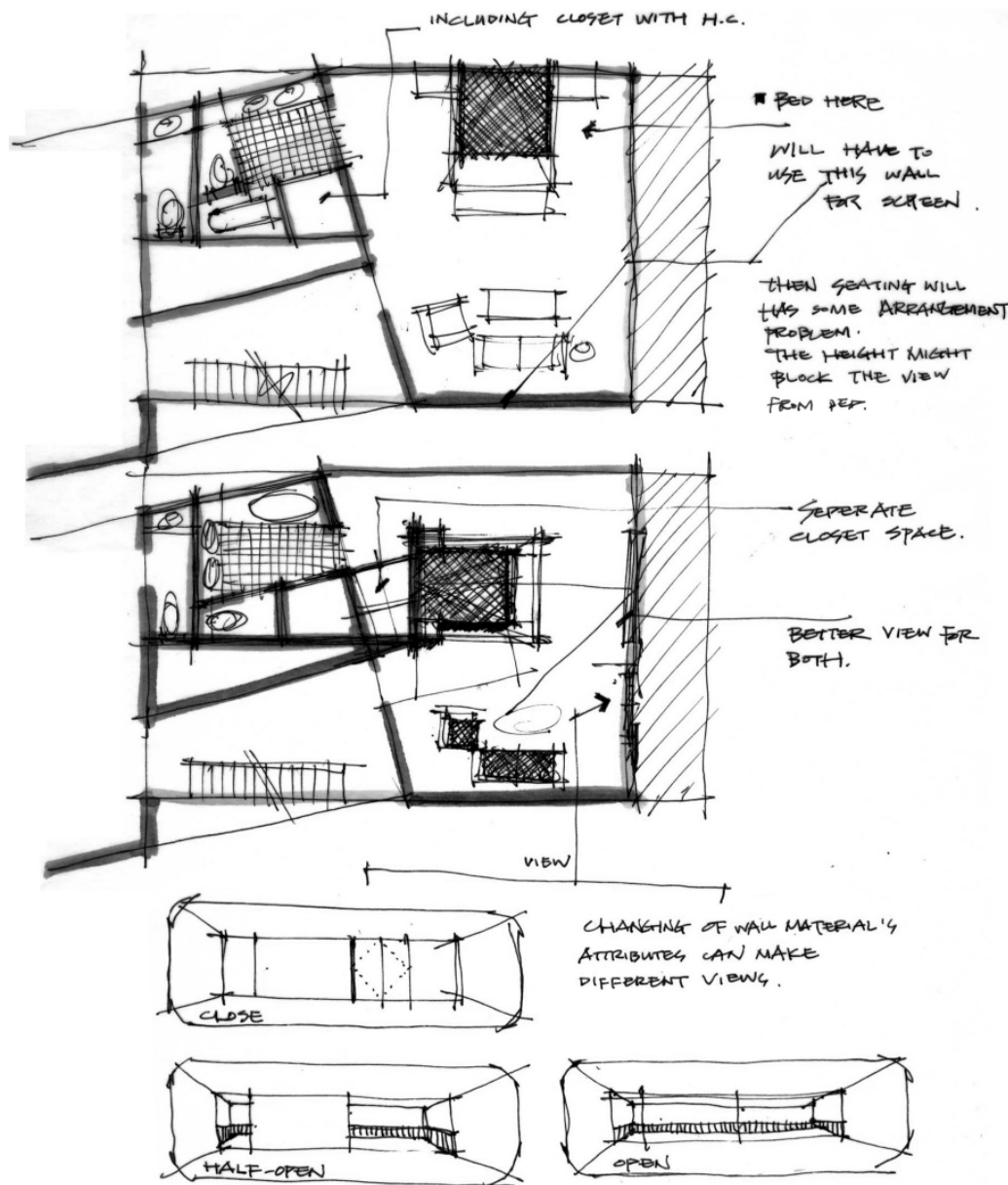


Figure 4-7. First floor plan.



*Figure 4-8.* The living space is flexible in space size and furniture arrangement. *Top:* Compact mode - when fewer activities happen in this space, simplest furnishings and smallest size will keep this space energy-efficient. *Middle:* Medium mode - when some activities perform here, this space can expand and more furnishings will add. *Bottom:* Large mode - when more activities require larger space, this space can expand to its largest mode.



For privacy purposes, the resting space is on the back part of second and third floors. It contains the bedroom, bathroom, and closet. The bedroom incorporates more entertaining features and more automation control. The bathroom has health care considerations added. The closet is attached to the service center, which has a whole new concept (refer to Figure 3-16).

The front part of second floor is working and study space. This space has simple furnishings, because many working and study activities will be done through computer-driven devices, and all of them will become thin, small, or even invisible. This space also can be resized to meet individual occupant's need.

Figure 4-9. Thinking process of resting space.



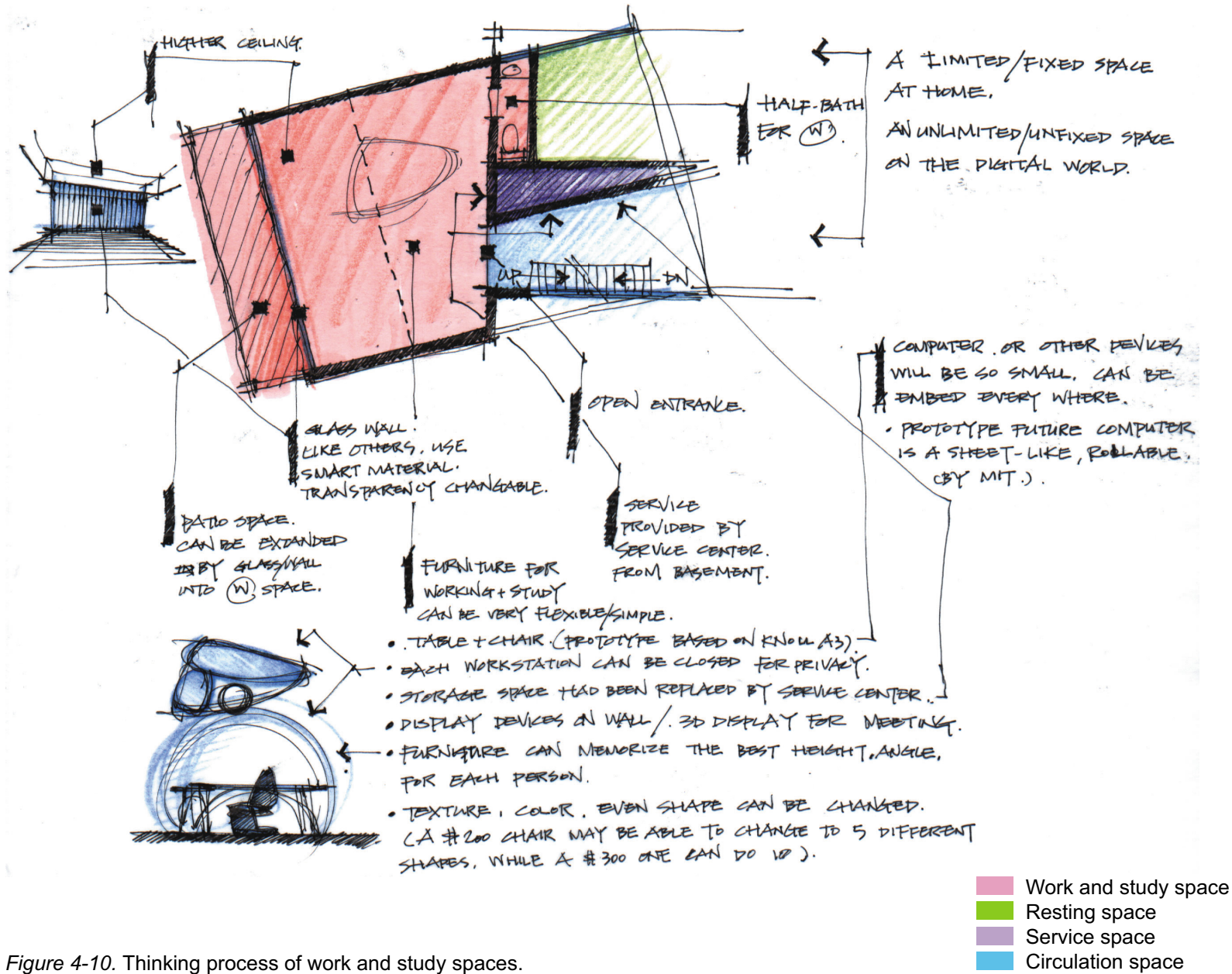


Figure 4-10. Thinking process of work and study spaces.



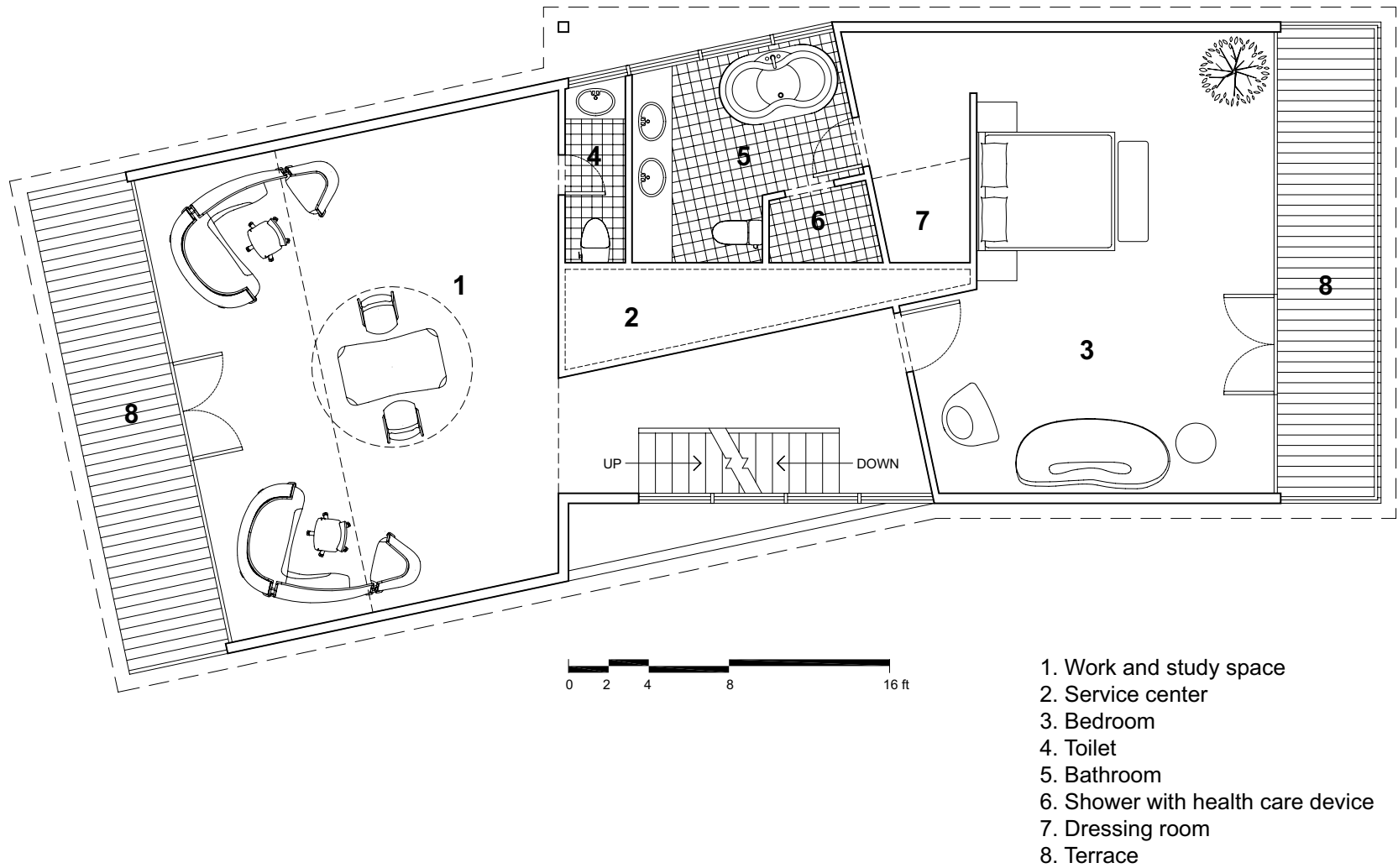


Figure 4-11. Second floor plan.

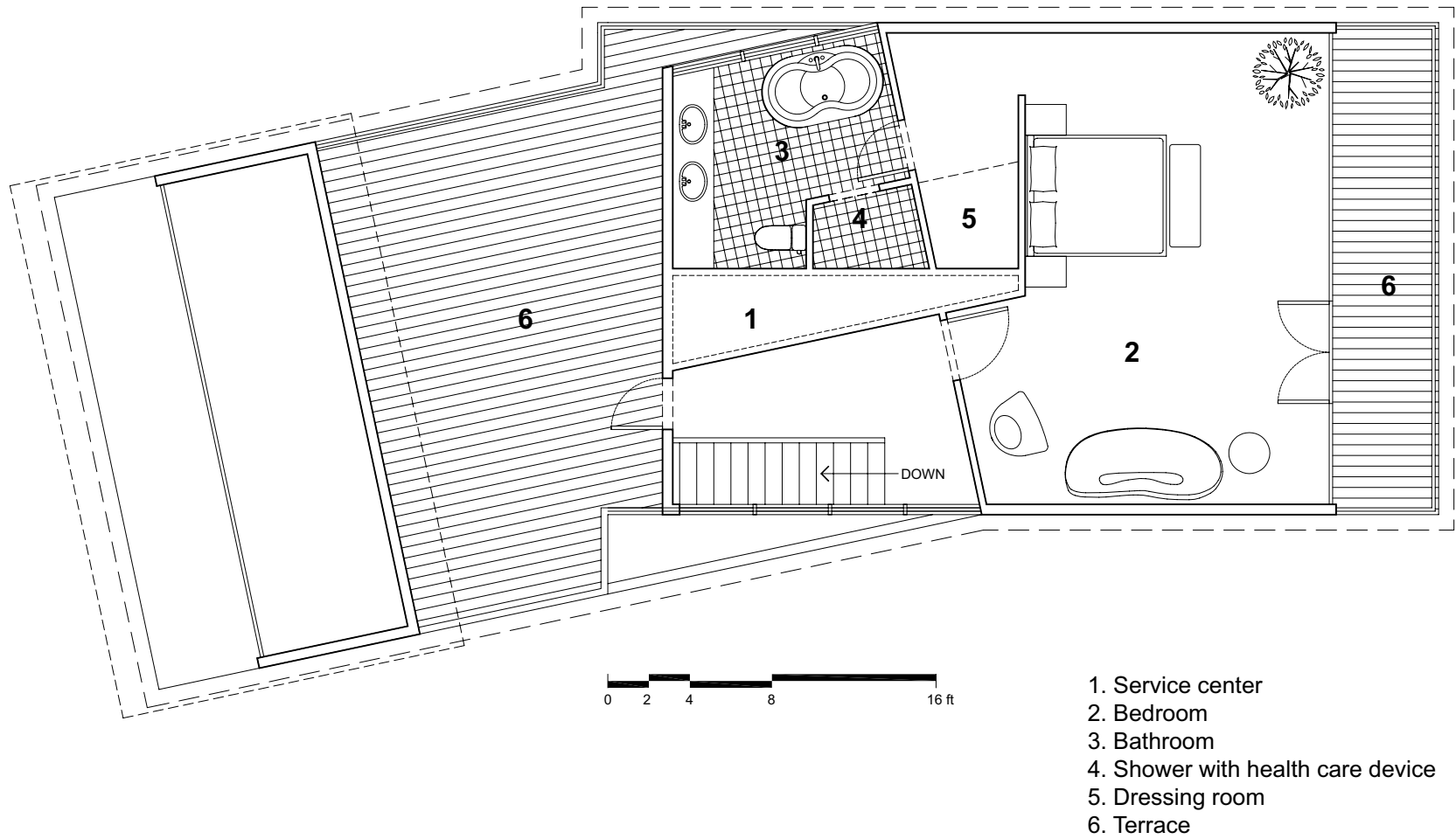


Figure 4-12. Third floor plan.

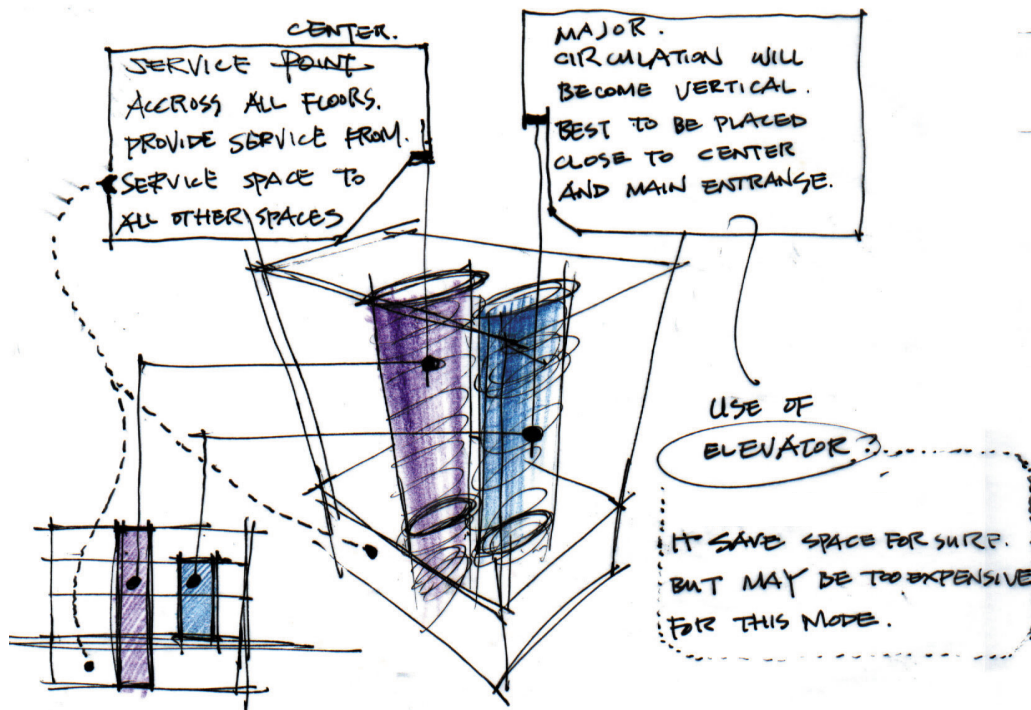


Figure 4-13. Ideas for service space and circulation space.

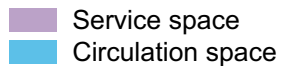
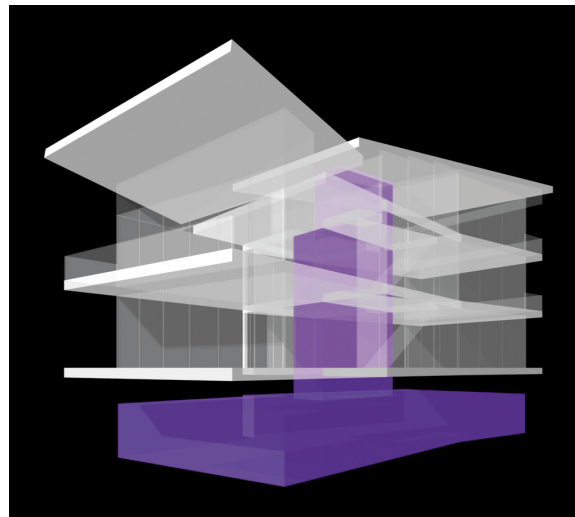


Figure 4-14. Service space provides service to primary spaces through service centers on every floor.



The main body of service space locates underground, and the service activities/functions move through the service center to primary spaces. The service center includes cabinets, closets, book shelves, pantry, trash areas, and mud room.

The primary spaces may vary in character and context by changing physical and visual features. Walls can move to make primary spaces resizable. New materials for walls and windows can change the transparency, or change the color and texture. A display screen may show any type of scene or design to reflect a different mode for the space.

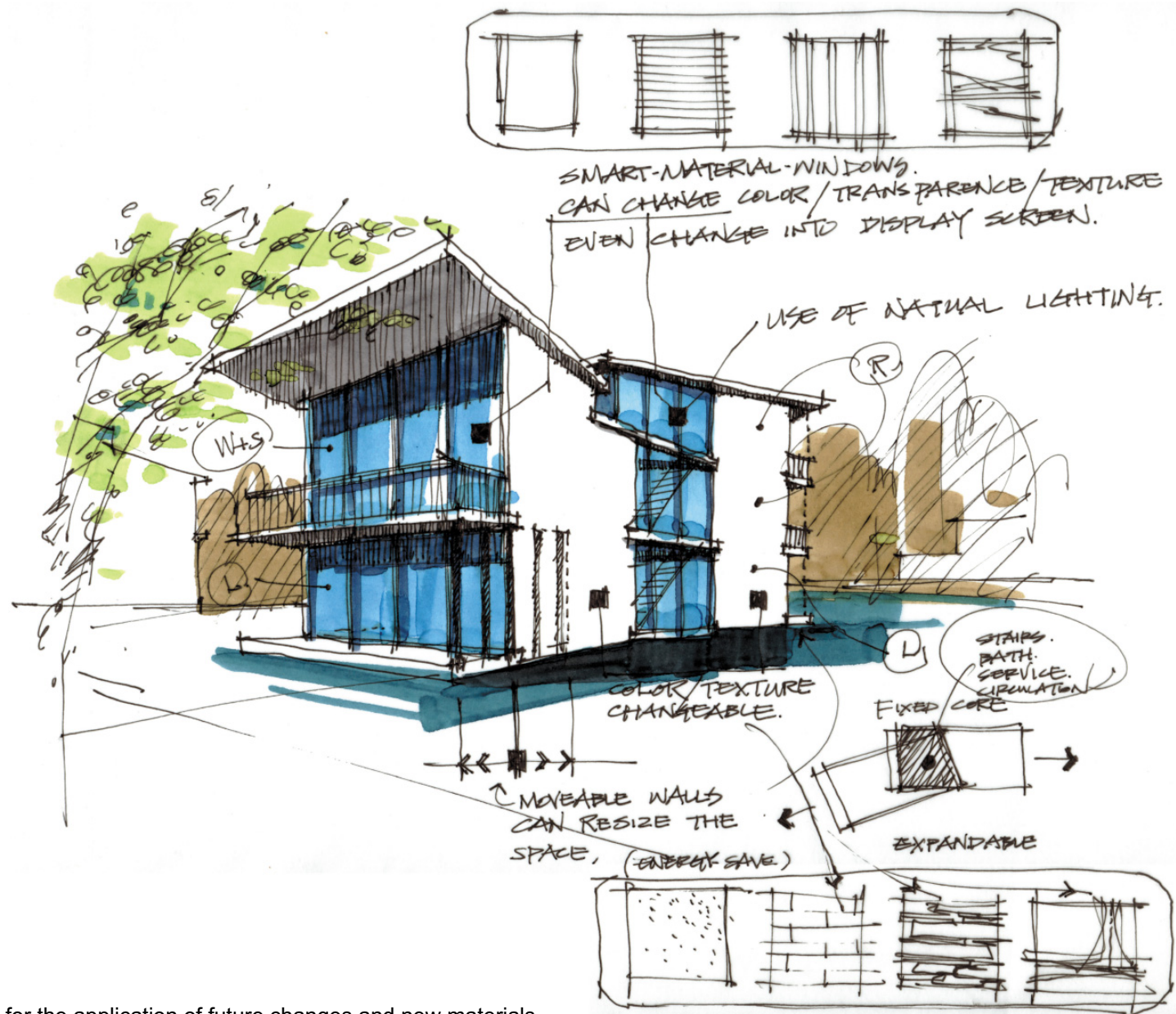


Figure 4-15. Ideas for the application of future changes and new materials.

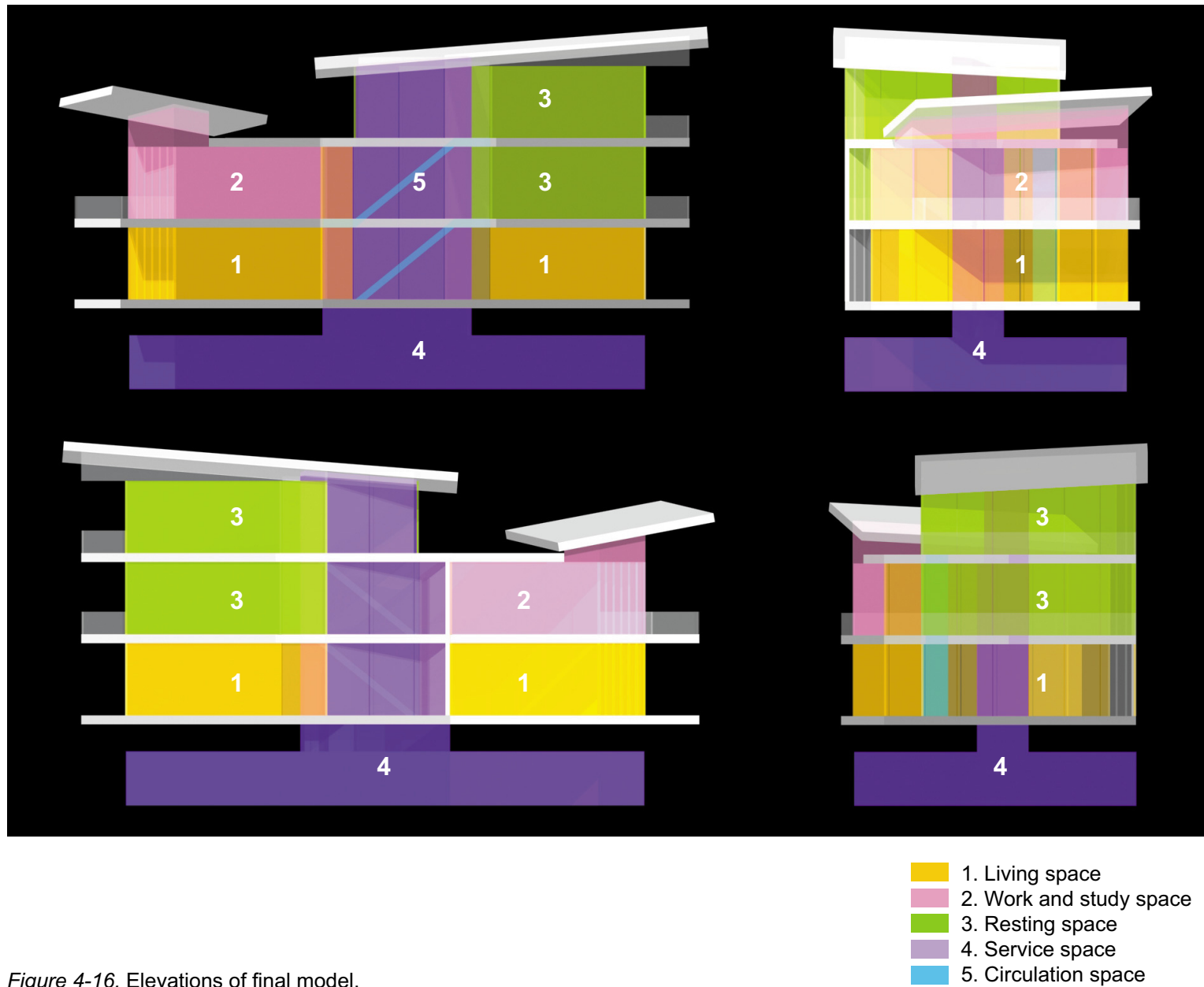


Figure 4-16. Elevations of final model.

## CHAPTER 5

# HIGH-END SOLUTIONS

INTRODUCTION

CHAPTER 1

CHAPTER 2

CHAPTER 3

CHAPTER 4

This prototype is designed for high-end level occupants. Compared to the middle-class version, this design has less limitation on size and scale, and it expands the use of technology. However, the main concept of the space construction of both versions is very similar.

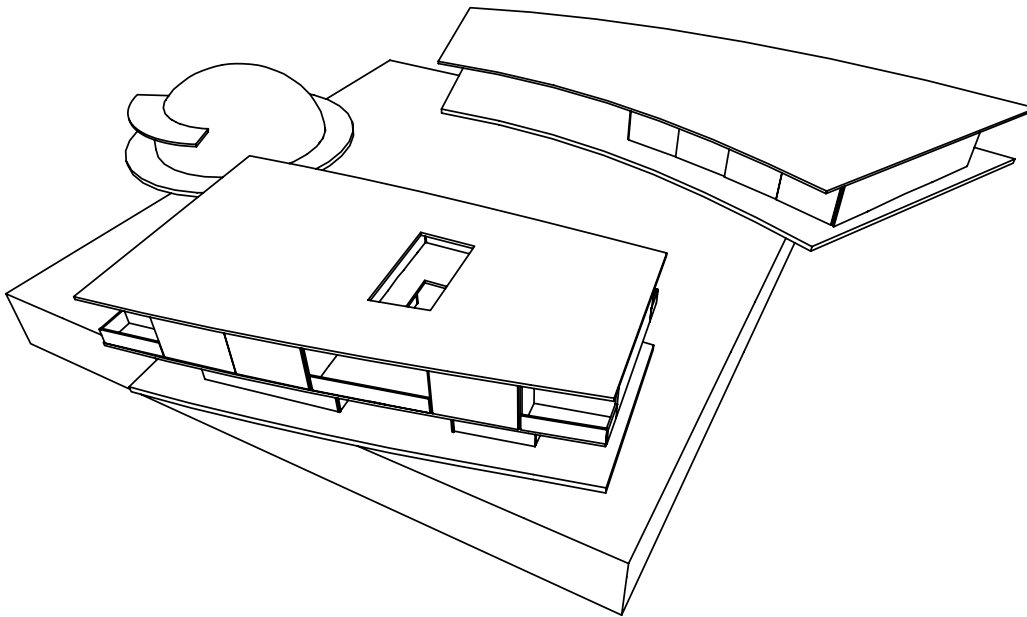


Figure 5-1. Study model for a high-end house.



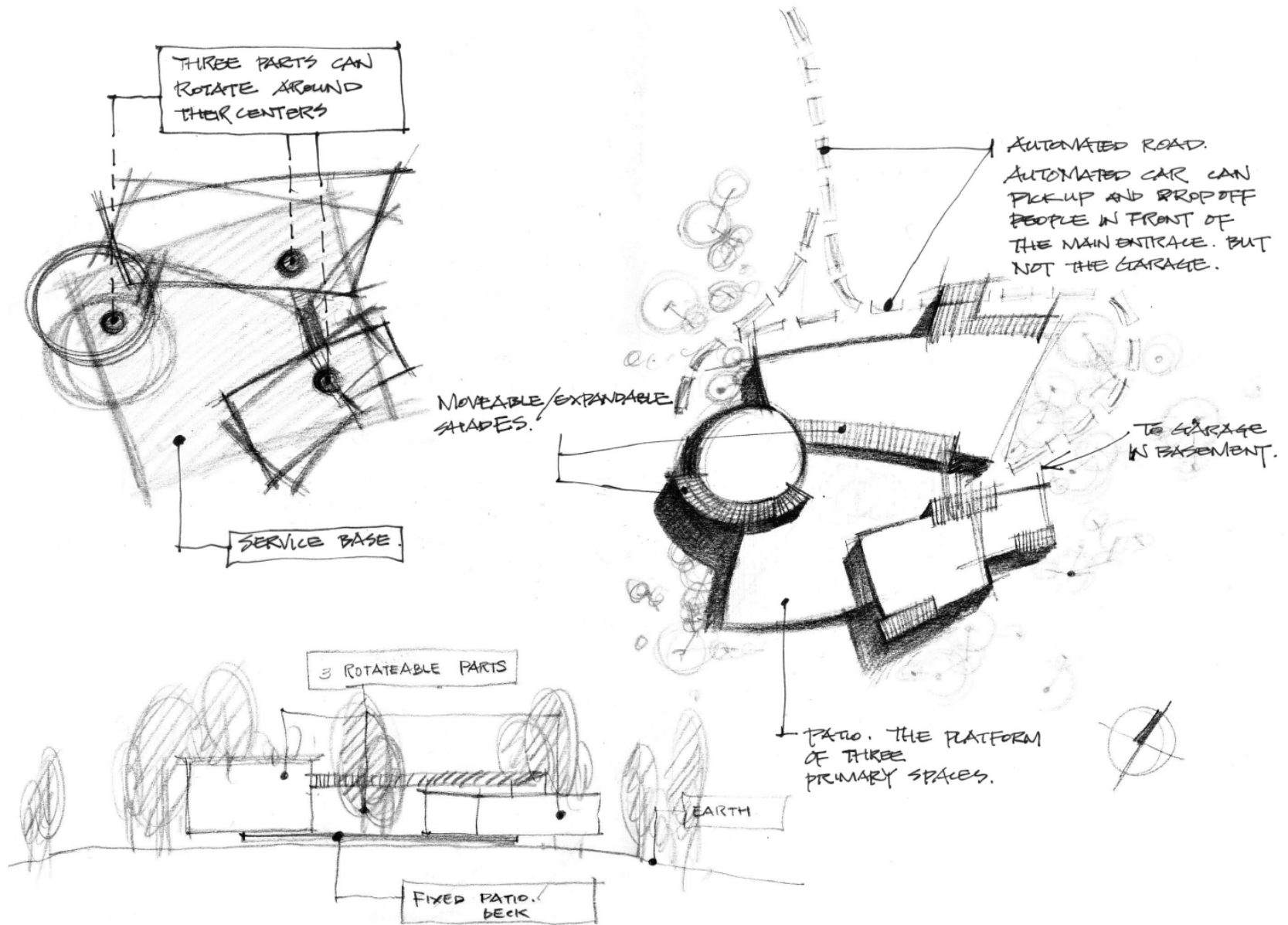
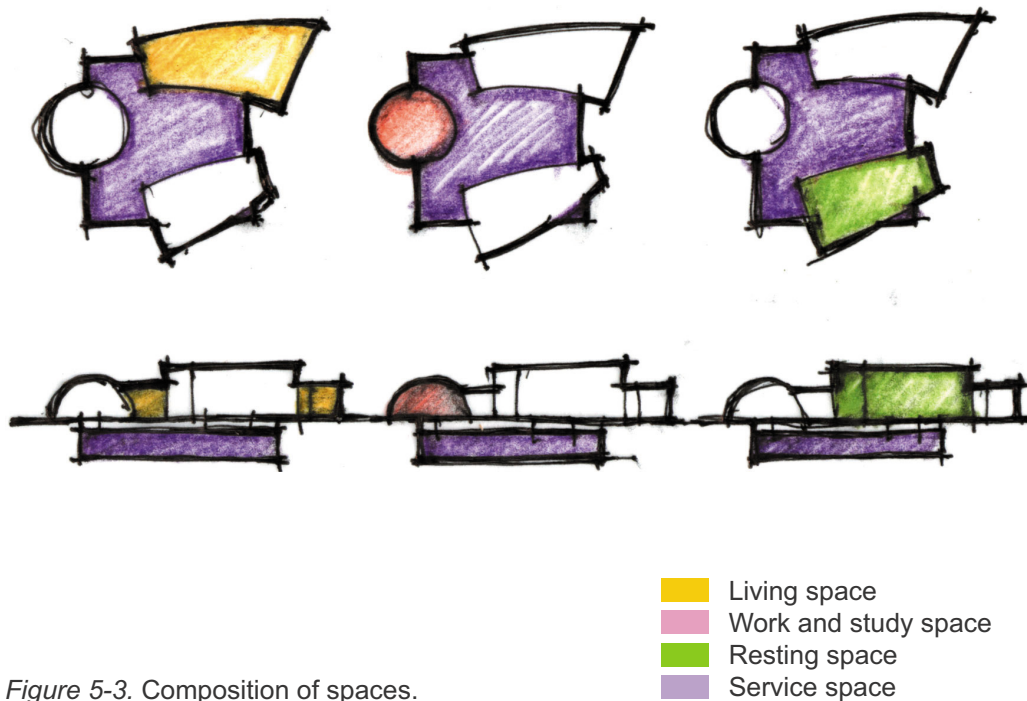


Figure 5-2. Conceptual ideas for a high-end house.



This design contains three buildings above the ground, dynamic links amongst them, and an underground level underneath them. The total space of this design is around 4,500 square feet.

From the vertical view, this design has two parts. The above ground part has three buildings for three primary spaces: living space, work and study space, and resting space; circulation space; and underground service space.



The living space has two main areas. One is for formal guest receiving. Similar to the same space in the middle-class version, this part has the simplest furnishings and smallest size. When the need for more space comes, this space has the ability to expand, and the furnishings will

accommodate the change to meet the need. The other area is for family use, which includes living activities, cooking, dining, and entertaining. The entertaining activities can also incorporate the front part as extra space.

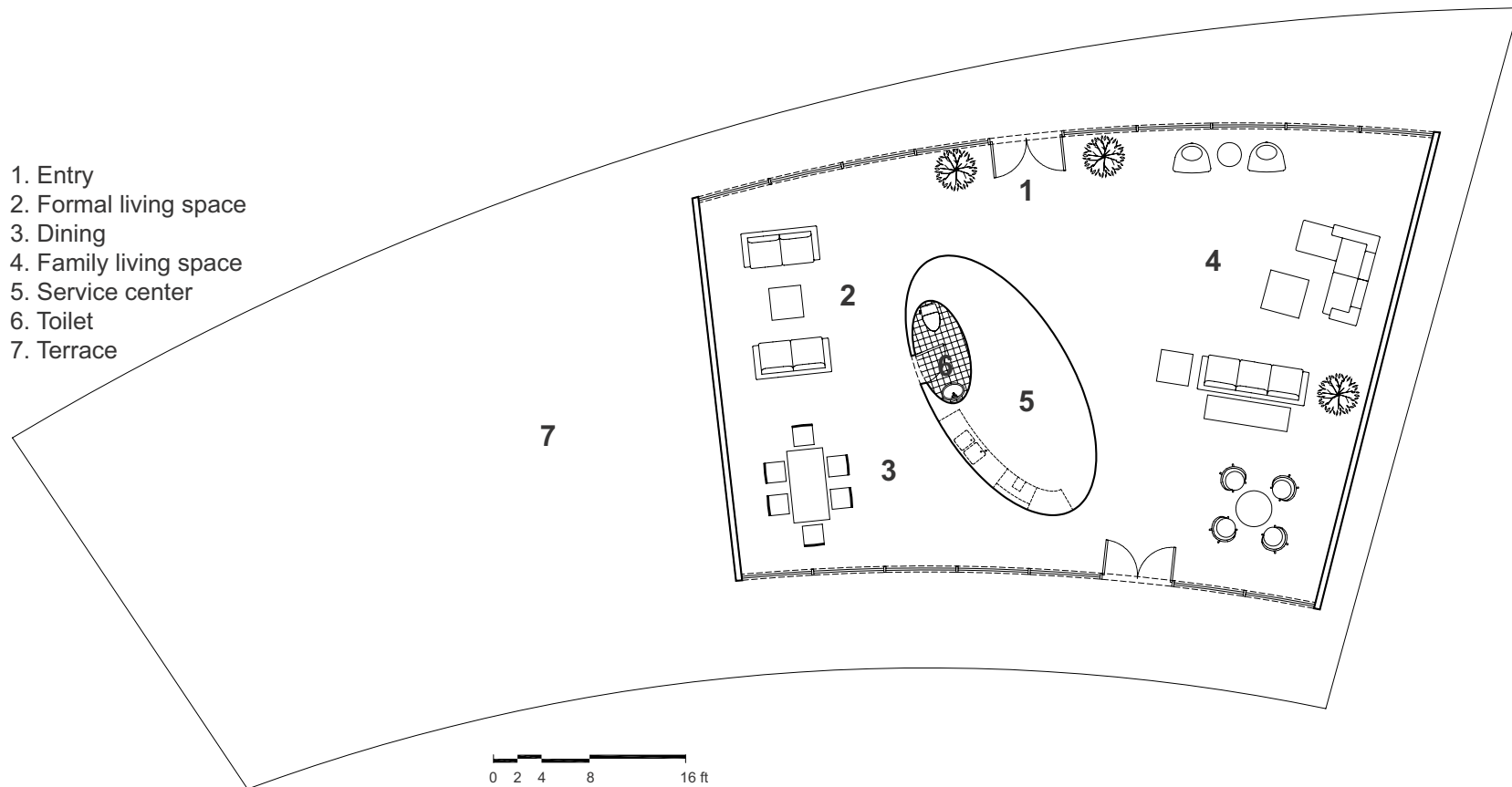


Figure 5-4. Living space floor plan.

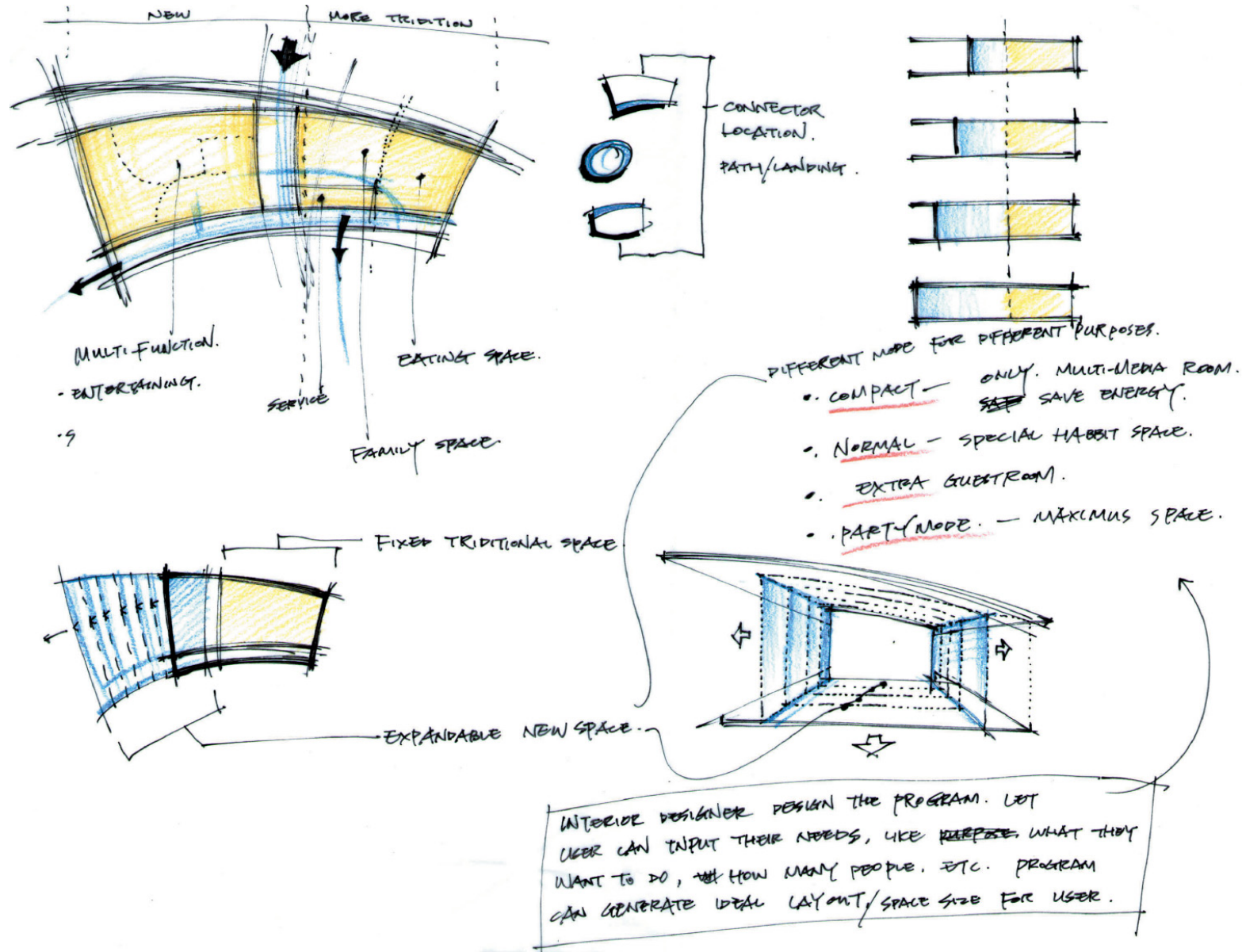


Figure 5-5. Considerations for resizable living space.

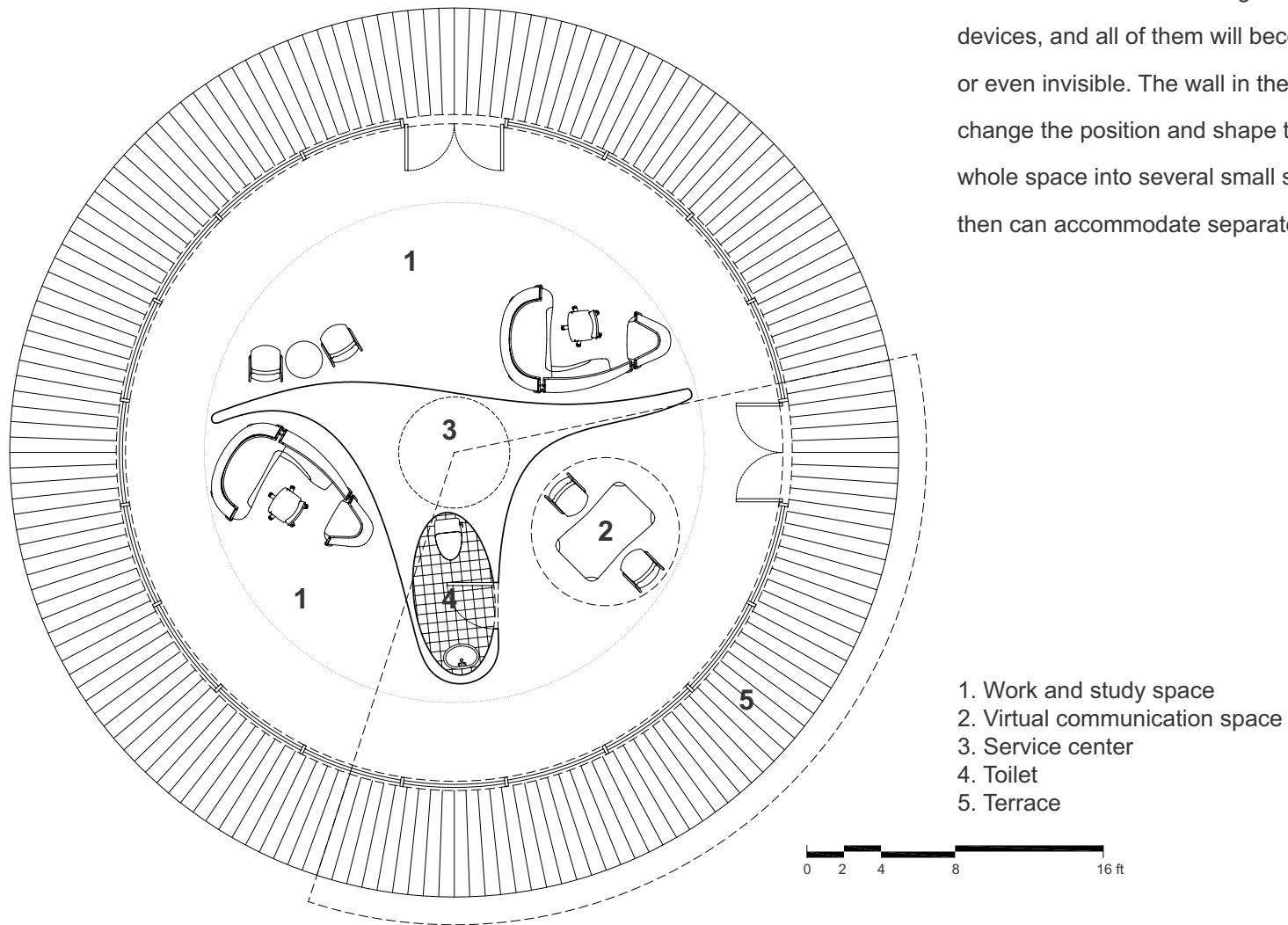


Figure 5-6. Work and study space floor plan.

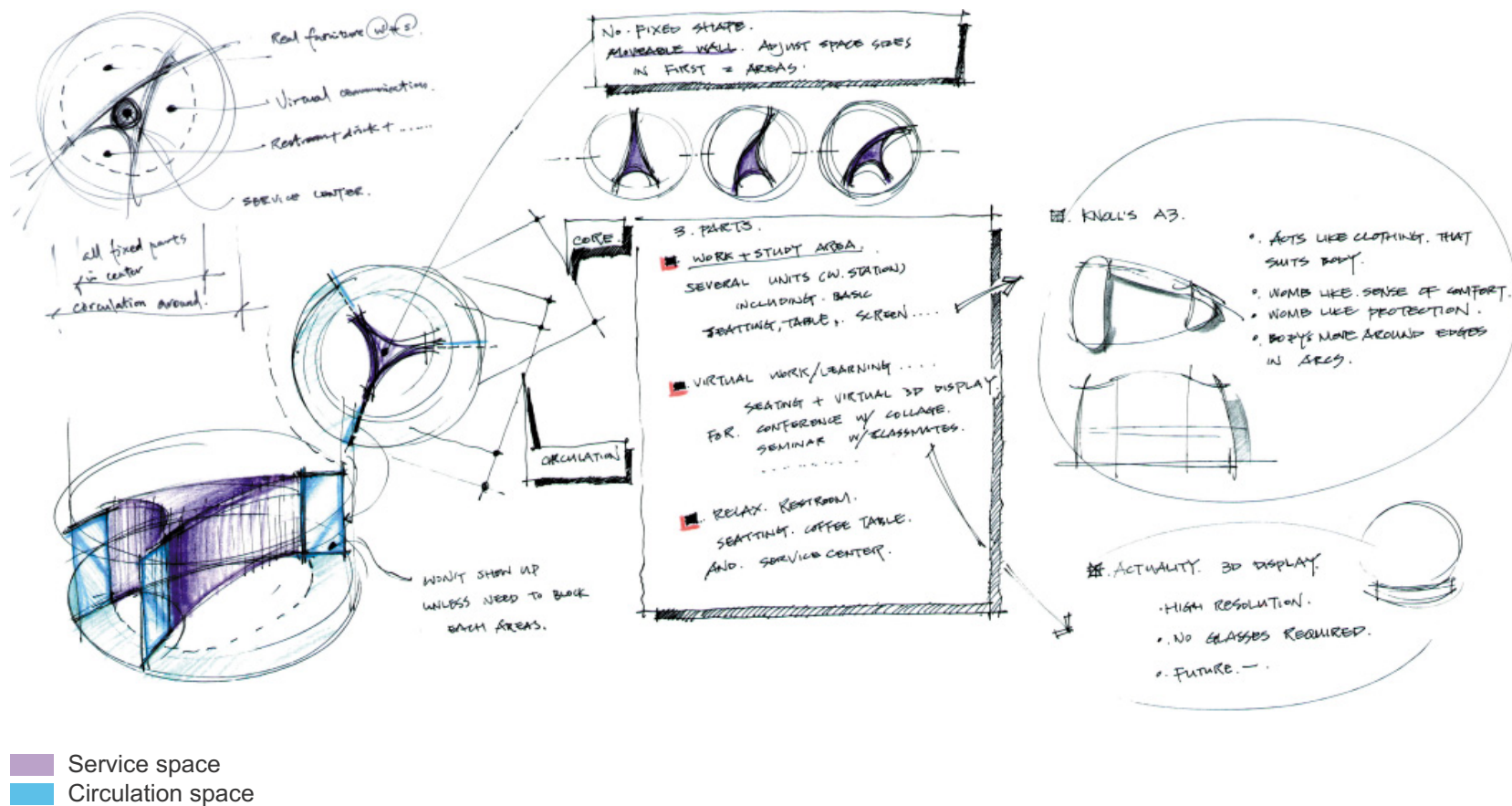
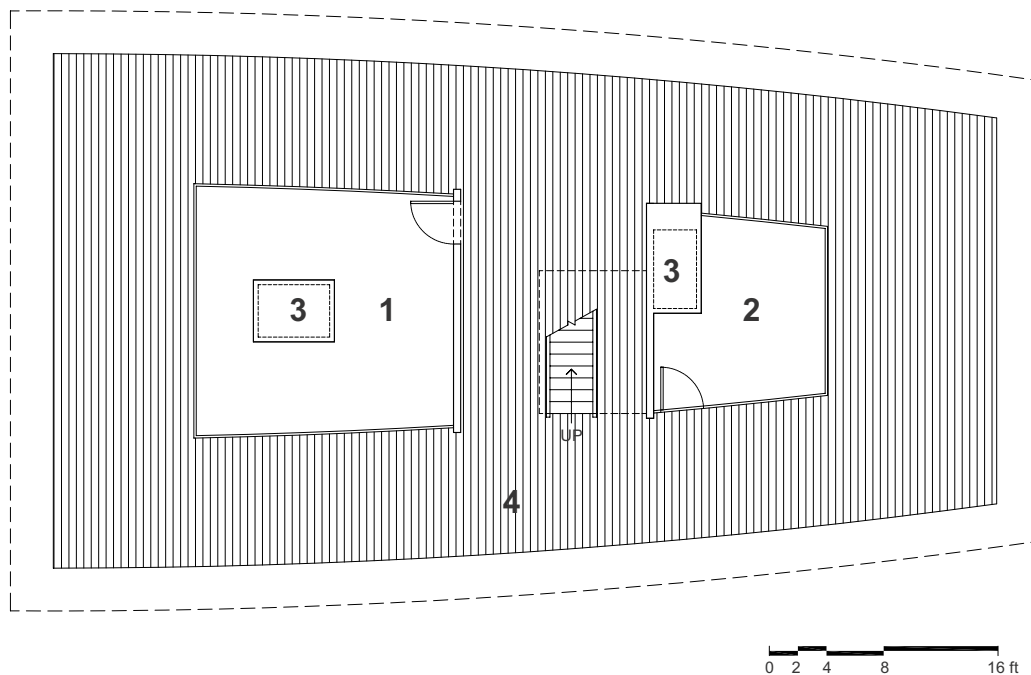


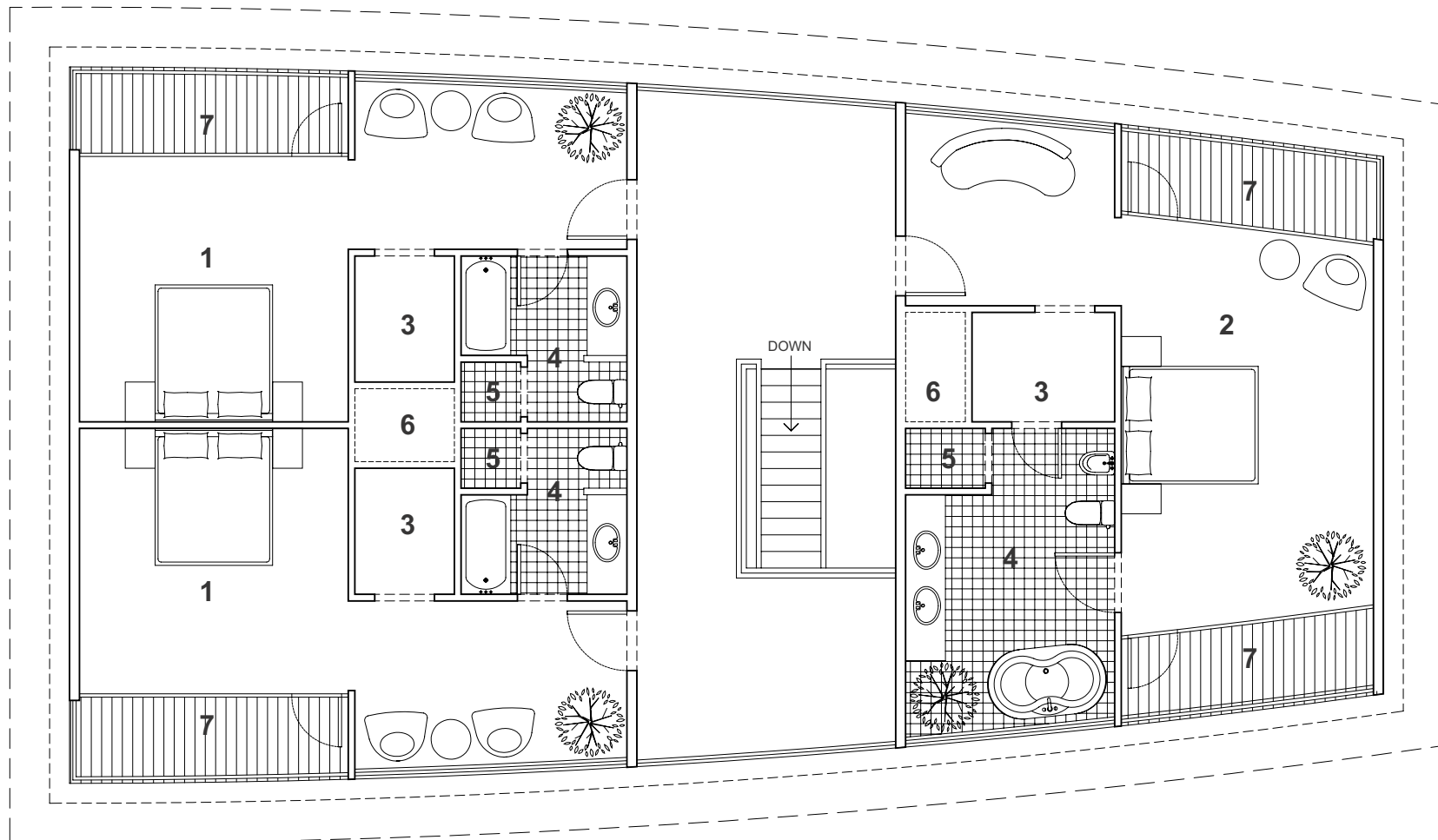
Figure 5-7. Ideas for work and study space.

The resting space has two floors. The second floor has three sets of bedrooms; each of them contains a bedroom, bathroom, and closet. The bedroom has more entertaining components and more automation control. The bathroom has health care content added. The dressing room is attached to the service center. The first floor has two resizable rooms for exercise and separate entertaining purposes.



- 1. Exercise
- 2. Entertaining
- 3. Service center
- 4. Terrace

Figure 5-8. Resting space first floor plan



1. Bedroom
2. Master bedroom
3. Dressing room
4. Bathroom
5. Shower with health care device
6. Service center
7. Terrace

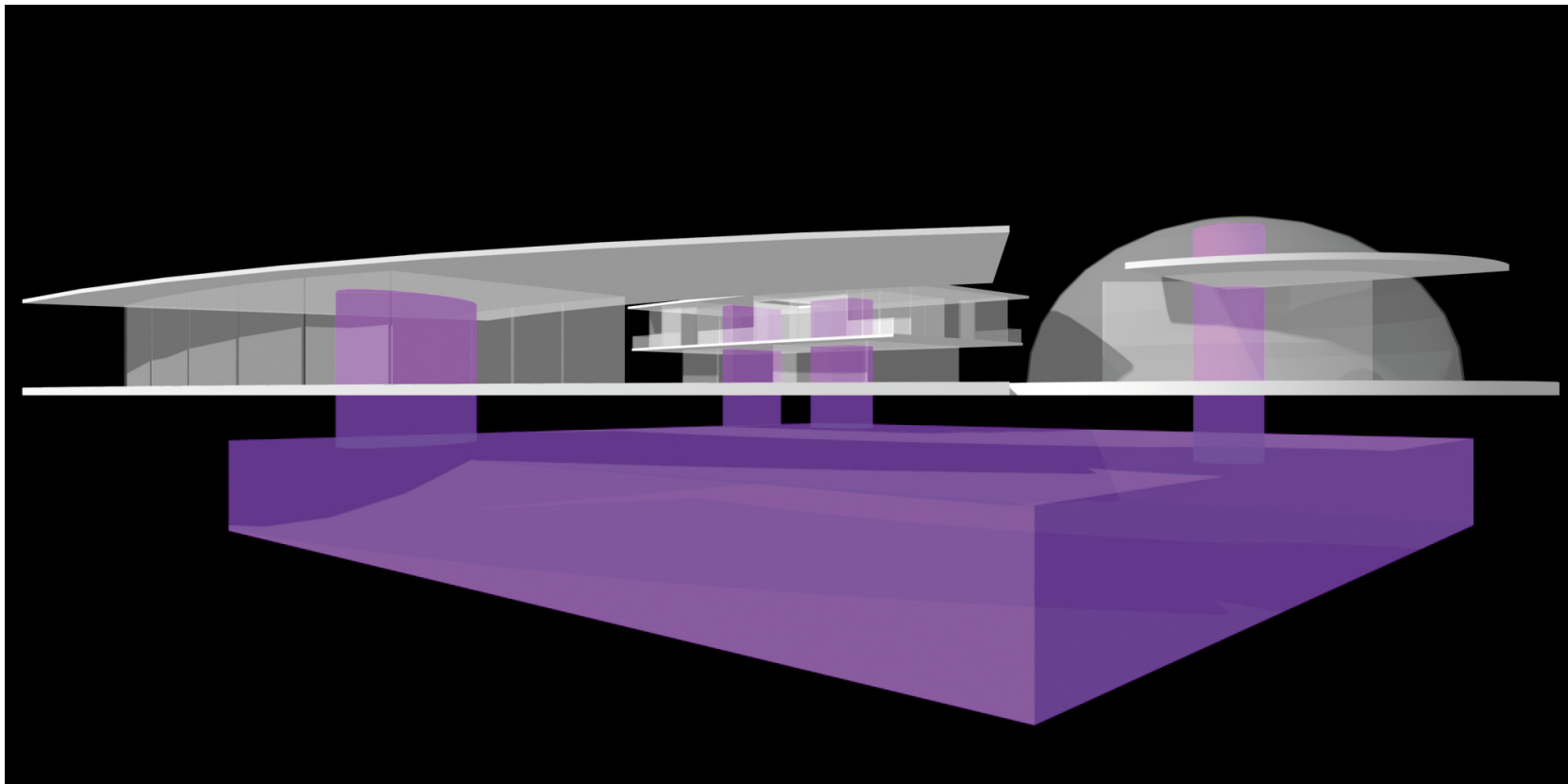


Figure 5-9. Resting space second floor plan.



*Figure 5-10.* The service space is underneath primary spaces, and provides service through service centers.

■ Service space



The main body of service space locates underground, and the service activities/functions move through the service center to primary spaces. The service center includes cabinets, closets, book shelves, pantry, trash areas, and mud room.



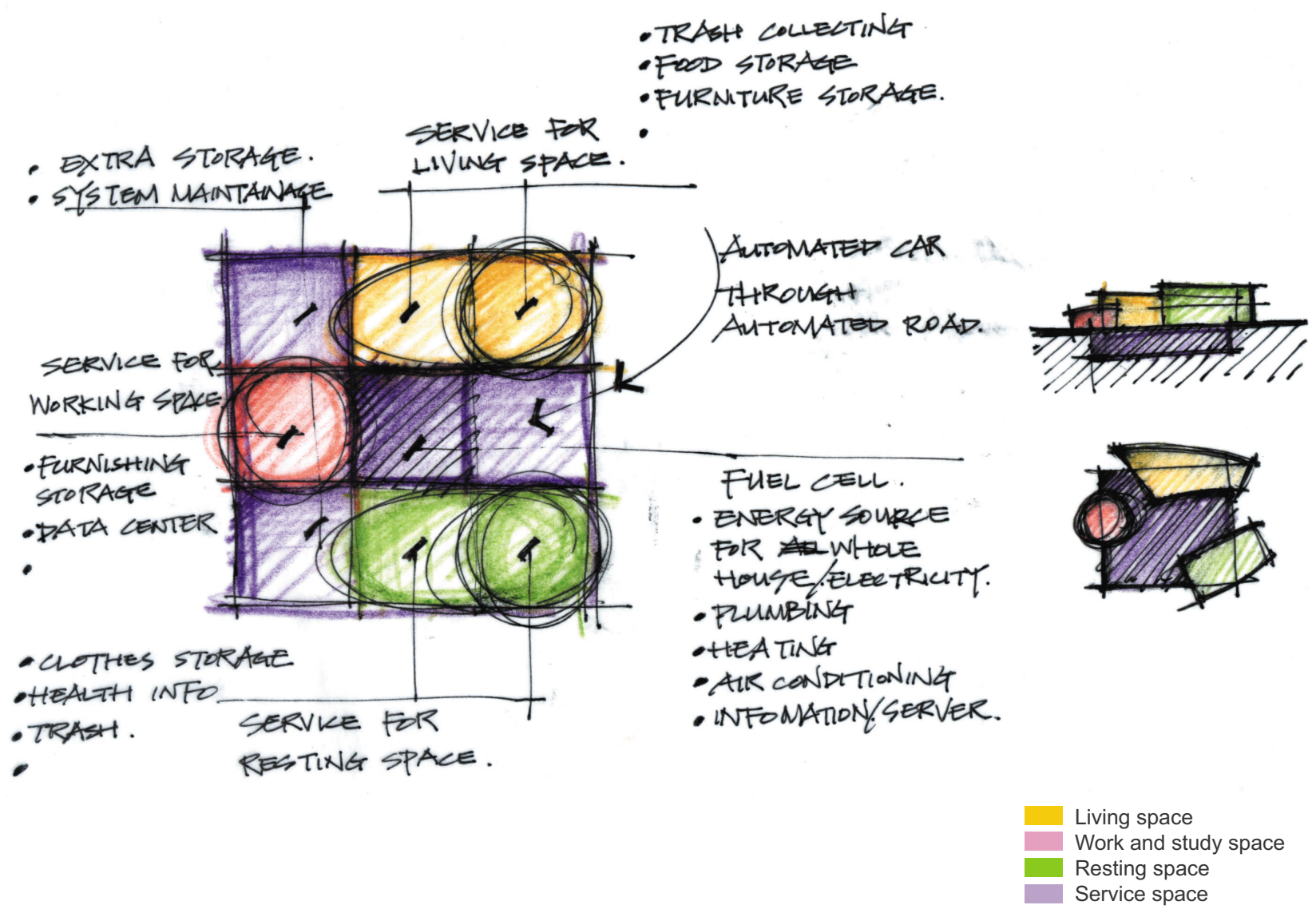


Figure 5-11. Ideas for service spaces.

- Living space
- Work and study space
- Resting space
- Service space
- Circulation space

The location of these three primary spaces is dynamic. Under different situations, the relationships between these spaces may change position based on need. The circulation space also becomes dynamic to provide the links between spaces.

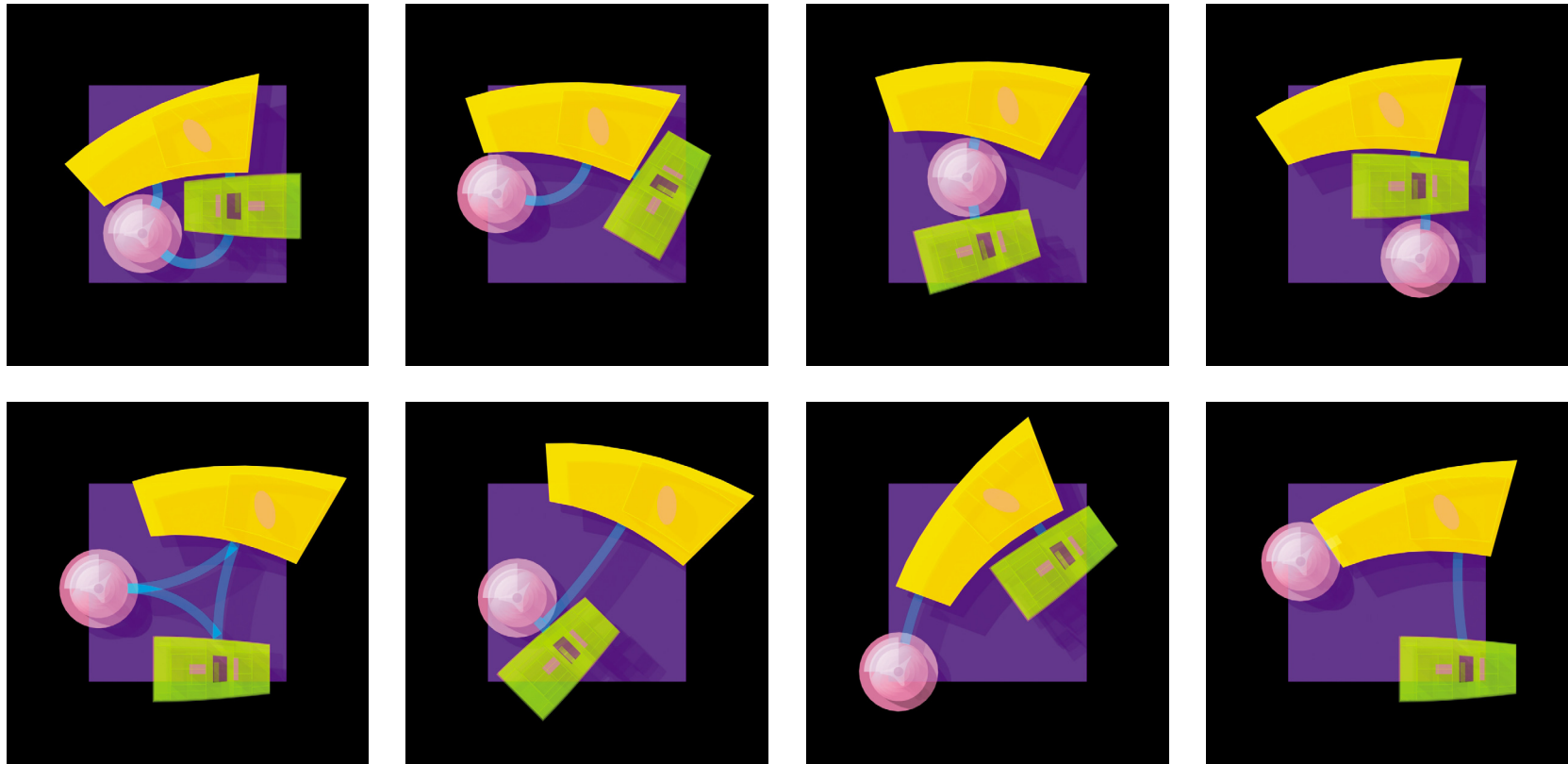
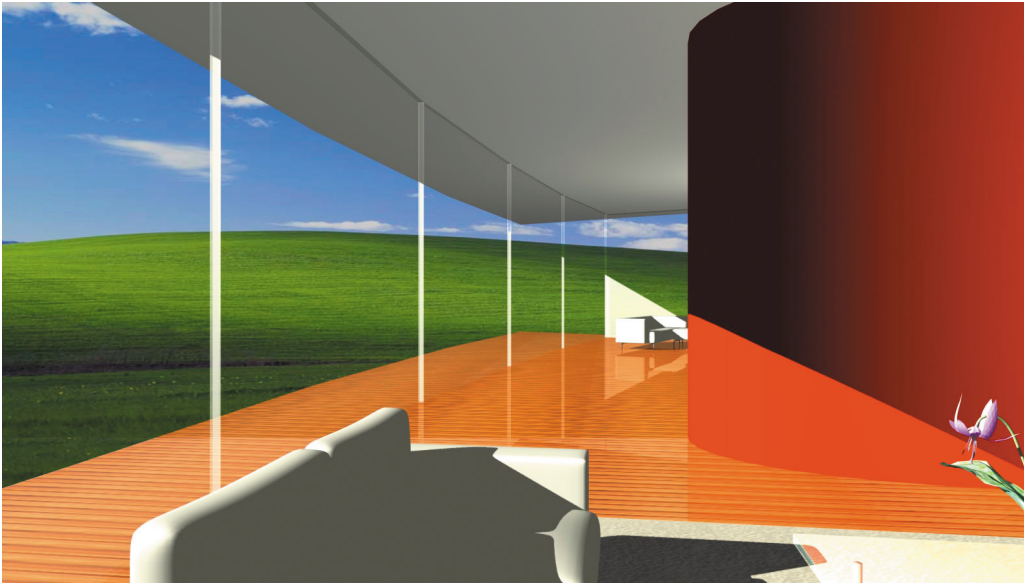
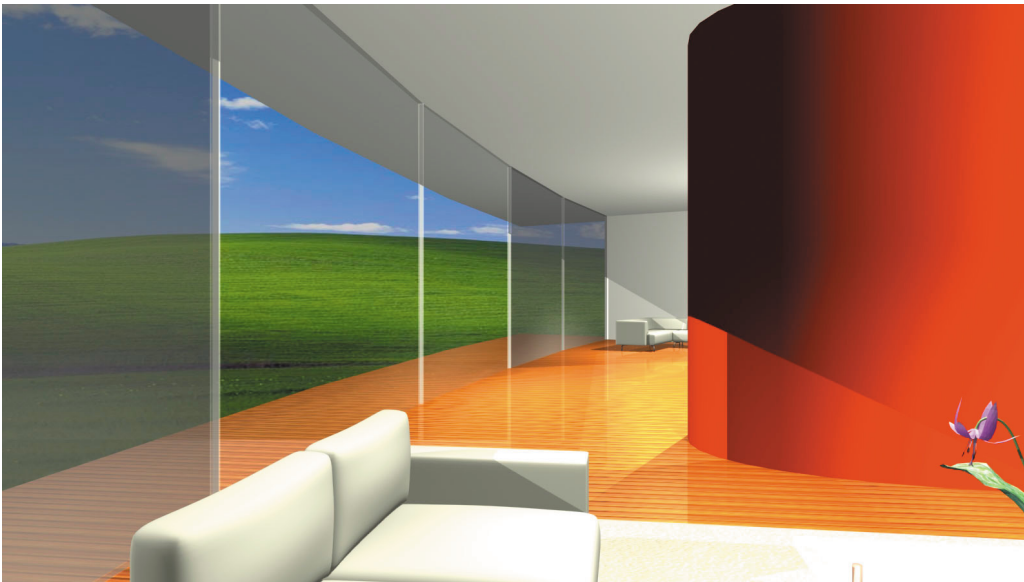


Figure 5-12. Primary spaces may move their positions to meet various needs.



The primary spaces may vary in character and context by changing physical and visual features. Walls can move to make primary spaces resizable. New materials for walls and windows can change the transparency, or change the color and texture. A display screen may show any type of scene or design to reflect a different mood for the space.



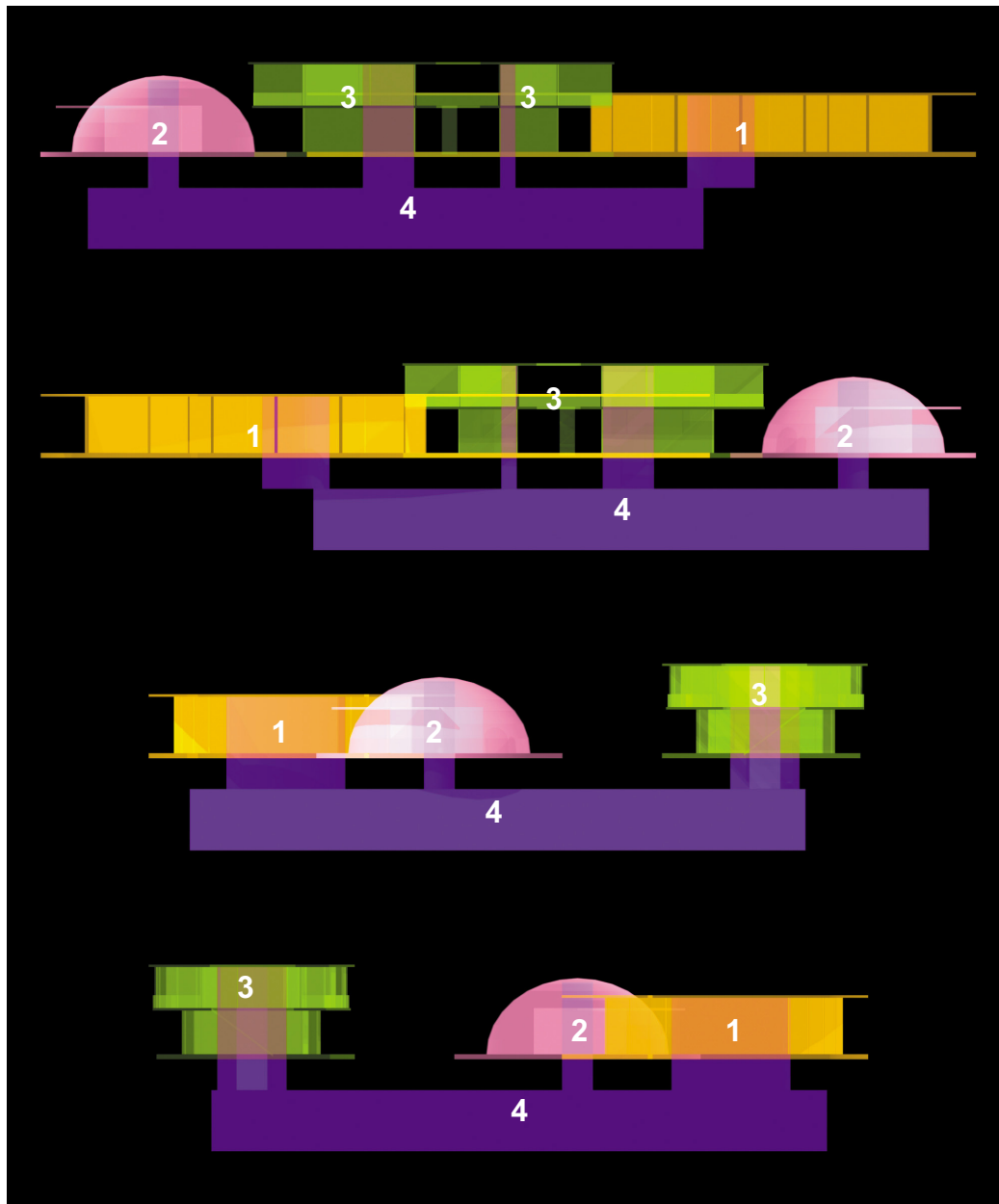
*Figure 5-13. Upper left:* The wall of the living space may be transparent to receive sunshine and observe a beautiful view.

*Figure 5-14. Lower left:* The wall of the living space may change the transparency to block the view.





Figure 5-15, 5-16. The walls, floors, and furnishings may also change color and texture to create a different mood or character.



- 1. Living space
- 2. Work and study space
- 3. Resting space
- 4. Service space

Figure 5-17. Elevations of final model.

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## **Vita**

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Ying Li was born on July 30, 1971, in Wuhu, China. He received his Bachelor of Arts in Interior Design from China Central Academy of Arts and Design, Beijing, China in 1994. For the next 5 years, he mainly worked as an interior designer in Beijing for the Environmental Art Development Center of China Central Academy of Arts and Design, and Beijing ZGHH Architectural Inc. He also worked as a computer illustrator, a graphic designer, and a web developer in Beijing and New York. In January 2000, he entered the School of the Arts at Virginia Commonwealth University to study on the graduate level.

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