

# SCIENTIFIC RESEARCH INSTITUTION PLANNING DESIGN

## 科研机构规划设计

(澳) 尼尔·阿普尔顿 编 常文心 孙阳 译

辽宁科学技术出版社

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# CONTENTS

## 目录

FOREWORD	002	前言
CHAPTER ONE	006	第一章
SCIENTIFIC RESEARCH & RESEARCH BUILDINGS		科研与科研建筑
What's the Research Building	006	什么是科研建筑
The Stages of Development of the Research Building	008	科研建筑的发展阶段
The Laboratory Space in the Budding Stage of Science	008	科学萌芽阶段的实验空间
Laboratory Buildings with Clear Discipline Classification	008	科目划分明确的实验建筑
Modern Scientific Laboratory Buildings with Diverse Spaces	009	空间多样化的现代科学实验建筑
The Diversified Development of Research and Laboratory Buildings	010	科研实验建筑多元化发展
CHAPTER TWO	012	第二章
THE CHARACTERISTICS OF MODERN RESEARCH BUILDINGS		现代科研建筑的特征
Take Great Advantage of Significant Local Elements	012	充分利用当地的有利因素
Diversity of Inner Functional Space	012	内部功能区的多样化
Pay Great Attention to Open Elements	013	设计中注重开放元素
Use New Materials and Hi-Tech	013	使用新材料及高科技材料
Demonstration on the Characteristics of Modern Science Buildings	015	现代科研建筑的特征案例展示
CHAPTER THREE	078	第三章
THE PLANNING OF LABORATORY SPACES		实验室空间的规划
The Requirements of Natural Environment for Research Buildings	078	自然环境对科研建筑提出的要求
The Relationship with the Surroundings	078	与周边环境的关系
The Control of Pollution	078	对污染的控制
Fitting to the Local Physical Geography	080	适应当地的自然地理特征
The Planning of Laboratory Spaces	082	实验室空间规划的重要内容
The Issues that Should Be Concerned in Laboratory Planning	082	实验室空间规划需要关注的内容



Benefits of Lab Planning Module	083	实验室模块的优势
The Requirements for the Spatial Flexibility	085	实验空间的灵活性要求
Efficient Lighting	088	实验室空间的采光要求
Safety Requirements	090	实验室空间的安全要求
Construction Criteria	096	实验室的建造标准
Cases of laboratory Space planning	113	实验室空间规划案例展示
<b>CHAPTER FOUR</b>	<b>196</b>	<b>第四章</b>
<b>THE TREND OF LABORATORY DESIGN</b>		<b>实验室的设计趋势</b>
Creating a “Social” Research Space Based on Collaborative Research	196	建造以团队研究为基础的“社会型”研究空间
The Balance between “Closed” Space and “Open” Space	198	“封闭型”空间和“开放型”空间的平衡
Creating a humane and Flexible Space	199	创建更具人性化的灵活空间
The Spatial Coordination between lab Facilities and Computer System	202	实验设施与电脑系统之间的空间协调
Sustainability	203	可持续性
Cases of the Trend of Laboratory Design	203	设计趋势案例展示
<b>APPENDIX</b>	<b>256</b>	<b>附录</b>
<b>METRICS AND BENCHMARKS FOR ENERGY EFFICIENCY IN LABORATORIES (QUOTE)</b>		<b>节能型实验室的度量标准（节选）</b>
Ventilation Metrics	256	通风度量标准
Cooling and heating Metrics – Special Considerations for Labs	258	制冷和供暖度量标准——实验室的特殊考量
Plug Load Metrics	259	插座负荷度量标准
Lighting Metrics	260	照明度量基准
How to Specify and Track Metrics – Process Considerations	260	如何明确和跟踪度量标准——流程考量
<b>REFERENCES</b>	<b>261</b>	<b>参考资料</b>
<b>INDEX</b>	<b>262</b>	<b>索引</b>





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SCIENTIFIC RESEARCH & RESEARCH BUILDINGS		科研与科研建筑
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The Stages of Development of the Research Building	008	科研建筑的发展阶段
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The Requirements of Natural Environment for Research Buildings	078	自然环境对科研建筑提出的要求
The Relationship with the Surroundings	078	与周边环境的关系
The Control of Pollution	078	对污染的控制
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<b>THE TREND OF LABORATORY DESIGN</b>		<b>实验室的设计趋势</b>
Creating a “Social” Research Space Based on Collaborative Research	196	建造以团队研究为基础的“社会型”研究空间
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<b>APPENDIX</b>	256	<b>附录</b>
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Ventilation Metrics	256	通风度量标准
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Plug Load Metrics	259	插座负荷度量标准
Lighting Metrics	260	照明度量基准
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<b>REFERENCES</b>	261	<b>参考资料</b>
<b>INDEX</b>	262	<b>索引</b>



### What's the Research Building

As a materialised space for scientific research, the research building is a socialised architecture designed for teamwork research. The laboratory is the core of the building because the development of contemporary science and technology is closely related to scientific experiments. Research depends on the application of the scientific method, a harnessing of curiosity. The research provides scientific information and theories for the explanation of the nature and the properties of the world. Researches can be divided into different classifications according to their academic and application disciplines. Laboratory buildings can also be divided into different classifications according to their specialisations (research, education and manufacture) and scientific disciplines (chemistry, physics, biology, medicine, etc.). Therefore, besides reflecting the characteristics of the discipline which the laboratory belongs to, the seemingly simple working tables and experiment operating programme must need supports from professional equipments, piping system and electric system. In other words, the emergence of research buildings is the inevitable demand of the development of scientific researches. Meanwhile, the development of research buildings is the reflection of the continuously improved demands of scientific researches.

Generally, research is understood to follow a certain structural process, observations, hypothesis, gathering and analysis of data, and finally conclusion. According to the process, research is totally teamwork. No one can do all the procedures, so every scientist should be responsible for one of those procedures, and then they are in collaboration with others to conclude. Members of the team should not only spend much time in their own laboratory alone, but also they should talk to their colleagues and discuss their new hypothesis and question about the research. Therefore, the research building should provide an open seminar and meeting room to accelerate the process of research. It should provide ample spaces for discussion and conversation. Scientists and their technical assistants spare no efforts to exchange their new findings, and make creative definition of the topic. The whole team becomes a well-functioning body. All the smart “brains” put forward the innovative hypothesis, and their “eyes”, “arms” observe and test the hypothesis, and again and again revise the analysis.

Individually, teams are composed of scientists and technical assistants. The fruit of the whole team relies on every member of the team. Every research may involve sitting in front of computer screens, and observe small objects under the microscope for many an hour around the clock. Hence, individual office cells may provide relatively quiet surroundings for researchers to focus on their own observations and calculations. Observation and calculation are of great importance, for researchers should take notes of the every step of experimental process, and instantly get down to the date analysis. Researchers should not miss or ignore every

### 什么是科研建筑

科研建筑是科学研究的物质空间，是适合团队研究的社会化建筑，其中的实验室部分是建筑的核心，现代科学技术的发展与科学实验息息相关。研究依赖于科学方法的应用，是对好奇心的驾驭。研究为解释自然和世界的属性提供了科学的信息和理论。根据学术和应用学科，研究可被分为不同的种类。实验室建筑也根据专业化（科研、教学、生产）和科学学科（化学、物理、生物、医学等）而分为多种。因此科研建筑除了体现实验室类型所属的系列学科特征之外，看似简单的实验室工作台和实验操作程序，往往需要各个专业的设备、管道系统、电力系统来支持。也就是说，科研建筑的产生是科研发展的必然要求，同时，科研建筑的发展也是科研对其不断改善的需求的体现。

从总体上来讲，科研是一系列观察、假设、收集和分析数据，最后得出结论的过程。根据这一流程，科研完全是团队的合作。没人能独立完成全部流程，因此每位科学家都必须为其中某一流程负责，然后合作起来进行总结。团队的成员不应只在自己的实验室里埋头工作，而应该与同事们进行交流，探讨新的假设和科研问题。因此，科研建筑应该提供一个开放的研讨室和会议室来促进研究流程，应该提供足够的讨论和交流空间。科学家和他们的技术助理不遗余力地交换新发现，为主题打造创新的定义。整个团队成为了高效的整体。所有聪明的“头脑”都提出创新的假设，而他们的“眼和手”则观察并测试假设，一遍又一遍地修订分析结果。

微观来讲，团队由科学家和技术助理组成。整个团队的成果依赖于团队中的每一个人。每项研究都可能是坐在电脑屏幕前或是日以继夜地在显微镜下观测微小的物体。因此，独立办公室能够为科研人员提供相对安静的环境，使他们专注于自己的观测和计算。观测和计算对研究十分重要，科研人员应该对实验的每个步骤进行记录，然后立即着手进行数据分析。他们不能遗漏或忽略任何细微的变化，因为那些遗漏的细节可能会导致实验的失败。因此，舒适的实验室环境能够为高强度工作的科研人员激发创造力，这种环境是一种资源，令人愉悦的办公氛围及适当私密的工作环境更有助于科研人员投入到科学实验中去。

detailed change, or those neglected details may probably lead to the failure of the experiment. Therefore, a comfortable laboratory environment will stimulate creation for researchers with intensive working. This kind of environment is a resource, for a pleasant office atmosphere and appropriately private working environment will be helpful for the researchers to do better scientific experiments.

The research building should also provide an environment of warmth and security. The building designer should not only take the well-equipped facilities into consideration, but also they may create a comfortable ambience for diligent and industrial scientists to enhance the quality of their work life. On the one hand, many scientists may burn the midnight oil, and even sleep in their office. So providing nutritious breakfast and a cup of sweet coffee may make scientist feel themselves at home. Providing food is very simple, but it will encourage researchers to spend more time in researching, and pursue their goals in academy with more diligence. On the other hand, apart from laborious research, scientist should spend much time in exercising and working out considering their health. Researchers may sit all day around in front of their computer. In this way, scientists may feel tired of their work day by day. The research building should provide a range of sports facilities.

科研建筑还应该提供温馨而安全的环境。建筑设计师不仅要保证建筑设施齐全，还要为勤勉的科学家提供舒适的环境，以提升他们工作生活的品质。一方面，许多科学家会经常熬夜，甚至睡在办公室，提供营养早餐和香甜的咖啡能让他们有家一般的感觉。提供食物很简单，但是这会鼓励科研人员花更多的时间进行研究，也让他们更勤勉地追求学术目标。另一方面，除了辛劳的研究，科学家还应该积极参与锻炼，保持健康。科研人员可能会整天坐在电脑前。日积月累，他们会异常疲惫。科研建筑应该提供相应的运动设施。



### The Stages of Development of the Research Building

New life styles will introduce new types of architecture. As the architectural space is where people work and live, the types of architecture will change according to mankind's modes of production and life. The scientific research can be divided into three stages: unified ancient philosophic science, scientific classifications from the Renaissance to the late 18th century and comprehensive science from 19th century to 20th century.

#### 1. The Laboratory Space in the Budding Stage of Science

In this stage, science was not an independent discipline but included in philosophy. At that time, many philosophers were working on scientific researches and experiments. With the influence of religion, the science was mostly focused on alchemy and astrology. Besides, limited by the scientific and technological level, the laboratories were simple and crude, usually located in residential buildings. Researchers worked on the initial experiments in these simple laboratory spaces, which gradually developed into normal laboratory buildings for researches. (See Figure 1)

#### 2. Laboratory Buildings with Clear Discipline Classification

In the early stage of the development of scientific research, research was still an individual activity. Therefore, there was no specific buildings for researches. Since the Renaissance, science became the discussion of a certain knowledge field because different fields need different experimental means and methods. After that, with the classification of natural science disciplines, the laboratory buildings were classified according to their specialisations (research, education and manufacture) and scientific disciplines (chemistry, physics, biology, medicine, etc.). Also, with the complication of experimental procedure, there emerged some specific discipline laboratory units consisting of several laboratories. They formed closed laboratory buildings with clear discipline classification. (See Figure 2-4)

Figure 1. A Medieval laboratory – from Baidu  
图1：中世纪的实验室——来自百度百科

### 科研建筑的发展阶段

新的生活方式的产生会引发新的建筑类型的产生。建筑空间是人们工作生活的场所，所以建筑类型也随着人们生产生活方式的转变而转变。科研建筑也是科研本身不断向前发展的必然结果。科学研究可大致分为三个阶段：统一的古代哲学科学、从文艺复兴到18世纪末的科学分类，19-20世纪的科学综合。相应地，反映科学发展趋势与水平的实验室设计和建造过程也经历了三个阶段。

#### 1. 科学萌芽阶段的实验空间

在这一阶段，科学没有独立成为一个学科，而是包含于哲学中。因此，当时很多哲学家，事实上也从事着科学研究和实验。而且在宗教信仰的影响下，科学研究多集中于炼金术及星相学领域。而且，由于当时科技水平的限制，早期实验室的条件相对单一简陋，并通常位于居住建筑内。科研人员就在这种单一简陋的实验空间内进行着最初的实验工作，后来逐步产生了一般的科研用的实验楼。（见图1）

#### 2. 科目划分明确的实验建筑

在科研发展的早期，科研还是个别人的活动，因此作为用于科研工作的专门建筑还不存在。从文艺复兴时代起，科学发展首先是对每一个知识领域的探讨，因为不同领域需要运用互相区别的实验手段和方法。而后，随着自然学科分类的细化，实验室建筑根据专业化（科研、教学、生产）和科学学科（化学、物理、生物、医学等）来分类。而且由于实验过程的复杂化，所以出现了由几个实验工作室组成的专门实验单元，分割出不同的科目的实验，这样就形成了实验科目划分明确的封闭性实验建筑。（见图2-图4）





### 3. Modern Scientific Laboratory Buildings with Diverse Spaces

#### Flexible Laboratory Spaces

(1) The comparably large open space is divided into several small units with different experimental activities and the staff are separated too.

(2) The connecting passages between spaces weave the separate spaces together and the organisation of transportation lines should provide convenience for the experiments.

#### Modern Research Buildings

With the social changes and the scientific and technological progresses, the development of science tends to be integrated and intensified, which needs efficient and large-scale organisation and coordination to conduct a series of scientific researches. Simple laboratory spaces can no longer satisfy the requirements of the development of contemporary science and the multi-

### 3. 空间多样化的现代科学实验建筑

#### 布局灵活的实验室空间

(1) 面积较大的开放空间中，因实验活动的不同而分成若干小单元，并把每个工作人员分隔开。

(2) 各空间相互联系的通道使相互分隔的空间融会贯通，及运输管线的布置要为实验提供便利。

#### 现代科研建筑

随着社会变革与科技进步，科学发展产生整体化、密集化的趋势，需要通过高效率、大范围的组织协调进行一系列科研开发项目，简单的实验室空间早已不能满足科技发展所带来的需求，复杂的多功能科研建筑综合群体日益受到科研工作者的青睐。在生物学和医学研究领域，科研

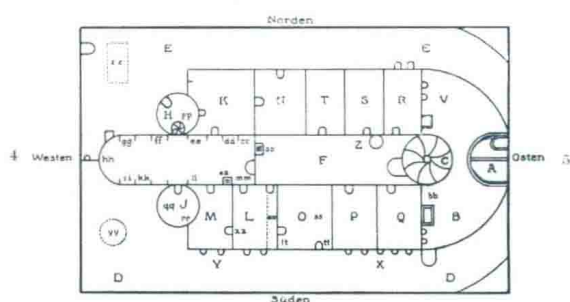
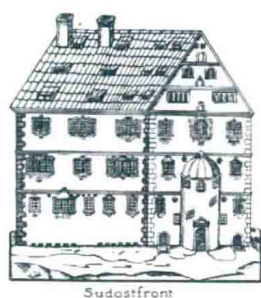
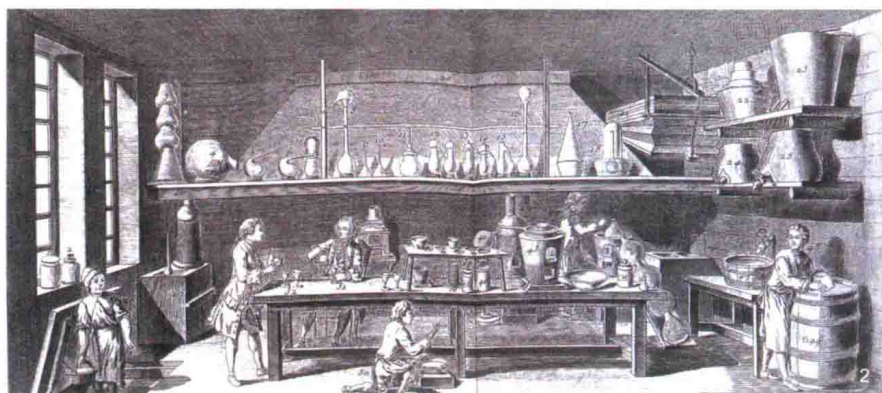


Figure 2. An 18th century chemistry laboratory from Diderot's Encyclopaedia

Figure 3. Andreas Libavius (1555 – July 25, 1616) was a German doctor and chemist.

Figure 4. This idealised design for a chemical institute in Andreas Libavius, Alchymia, 1606. It contains a main laboratory with furnaces for water-baths, ash-baths, and steam-baths; distillation apparatus for upward and downward distillation, with and without cooling; sublimation apparatus, fireplace; reverberatory furnace and large bellows. The analytical laboratory contains assay furnaces and analytical balances, some in cases. The private laboratory contains a philosopher's furnace. There is also in the institute a preparation room with press, a pharmacy, a crystallisation room, etc. The laboratory has water laid on, and in the open air there are facilities for making alum and vitriol, and a saltpetre plantation.

图2：狄德罗百科全书中18世纪的化学实验室

图3：安德里亚斯·利巴菲乌斯（1555–1616.7.25），德国医生和化学家。

图4：这所完美的化学实验机构专为安德里亚斯·利巴菲乌斯设计，建于1606年。它的主实验室包含水盆、灰盆和蒸汽盆的熔炉；用于上行和下行蒸馏的蒸馏器，有些还带有冷却装置；升华器、壁炉；反射炉和大型风箱。分析实验室内设有试金炉和分析天平，其中一些放置在柜子里。私人实验室内放有利巴菲乌斯的熔炉。建筑内还设有准备室、药剂室和结晶室等。实验室配有给水设施；露天区域则设有明矾和硫酸的制作设施以及硝石生产处。



functional complex is becoming more favourable to researchers.

In the field of biology and medicine, the research requires experimental animals to grow up in a certain condition which is different from normal atmospheric environment. Thus the biological cleaning technology emerges. The animal laboratory adopts completely closed environment with manual control, no-barrier large spatial layout and changing cage locations according to different breeding requirements. In order to meet requirements of illumination and ventilation, the researchers not only control the storey height of the research building, but also take full advantage of the roof and illumination intensity difference to conduct experiments. (See Figure 5)

### 4. The Diversified Development of Research and Laboratory Buildings

#### (1) From Single Building to Multi-wing Complex

Ever since Andreas Libavius designed the first laboratory building all over the world in the 17th century, various types of research buildings and composite design methods have emerged. The scale and scope of scientific research in the 17th century decided that the single building would meet the demand. Individual buildings separated different disciplines spatially and cut off their relationship. With the development of industrial manufacturing and the expansion of education and research institute, single buildings can no longer meet the development of modern science's requirements. For example, there is a design method to separate the research rooms from the main building, so that the research rooms are both independent from the laboratories and connected to them, which forms a wing composite plan, such as the Bell Laboratory in America. (See Figure 6)

#### (2) The Diversification and Standardisation of the Floor Plan

In 1960s, people developed an architectural form which took a standard-size space as the traffic junction and could be developed horizontally. The single volume can be flexibly divided into large areas according to the requirements of researches. The flexibility of the building was thus achieved through large areas and the junction.

The spatial forms of research buildings have gradually got rid of scattered layouts and moved towards intensified integration. They present an open status in terms of time and space. And with the reasonable sharing of physical resources, it forms an integrated mode of scientific research, study and life. (See Figure 7)

Figure 5. The iconic laboratory. Heinrich Wieland in the Baeyer Chemistry Laboratory, University of Munich, circa 1925. Edgar Fahs Smith Collection P/L 112.23 M. Courtesy of Rare Book and Manuscript Library, University of Pennsylvania.

图5: 标志性的实验室。海因里希·维兰德于1925年在慕尼黑大学贝耶尔化学实验室。E·F·史密斯的收藏P/L 112.23.M。版权由宾夕法尼亚大学善本和手稿图书馆所有。

的进展要求实验动物是在一定的环境状况下生长的, 而不是通常的大气环境, 生物洁净技术应运而生。动物实验室采用了完全封闭的人工控制环境, 无遮拦的大空间室内布置及根据不同的饲养要求改变笼养位置。所以为了满足光照和通风等条件的需求, 科研人员不仅对科研建筑的层高有所要求, 而且也会充分利用科研建筑的屋顶、光照强度的差异来进行实验。(见图5)

### 4. 科研实验建筑多元化发展

#### (1) 单体建筑向多翼组合发展

自从17世纪Andreas Libavius设计了世界上第一栋实验室建筑以来, 出现了多种科研实验建筑类型和组合设计方法。17世纪科学研究的规模和范围决定了单体建筑足以满足当时需要。独立的建筑使各学科专业在空间上相互隔绝, 割裂了彼此间的联系。随着工业生产的发展、教育科研机构规模的增大, 单体建筑已不能满足现代科技发展的要求。例如, 研究室与实验室建筑主体分离出来就是一种设计方法, 研究室既独立于实验室又保持联系, 通常形成一种侧翼组合平面, 如美国的贝尔实验室。(见图6)

#### (2) 平面设计多样化、标准化

20世纪60年代后, 人们发展了一种以标准大小的建筑空间环绕交通枢纽、可以沿水平方向发展的建筑形式。建筑单体为一个可根据科研工作需要灵活分割的大空间, 通过大空间和枢纽体的连接两种手段使建筑灵活性得以实现。

科研实验建筑的空间形态已逐步摆脱零散布局走向集约化整合的形态, 在时间上、空间上呈现开放状态, 物质资源的合理共享, 并形成了科研、学习、生活一体化的模式。(见图7)







6



7

Figure 6. Bell Labs' headquarters is in the USA was designed by Eero Saarinen. The 2,000,000-square-foot building was constructed between 1957 to 1962, which could contain 6,000 staff.

Figure 7. The length of the perimeter corridors were kind of daunting but really amazing with the light.

图6：贝尔实验室（Bell Labs）美国总部由Eero Saarinen设计。修建于1957年至1962年，200万平方英尺，可容纳6,000名员工。

图7：环形走廊的长度令人惊叹，在光照下的效果美轮美奂。



What makes research buildings characterise? What makes research buildings differ from other buildings? What makes research buildings become research buildings? You may find these answers in the following part.

Generally, many factors make great influence on the design and construction of the building. In addition, research buildings, as the representative of knowledge-intensive occupations in our industrial society, demand more special designs in power-saving and environmental protection.

### Take Great Advantage of Significant Local Elements

Research buildings can take great advantage of local geographical factors. When it comes to the weather, we cannot but think of the temperature. Many research buildings are located in the places where it is very hot and with abundant sunshine. As the saying goes, each coin has two sides. On the one hand, the design team can apply the play of the light and shade to botanical research. On the other hand, in response the extreme temperature and intense heat of the sun, designers have to try new technical ways to reduce the indoor temperature. Apart from temperature, the humid climate can also be taken advantage of. Although highly humid climate may result in the uncomfortable feelings, designers are so intellectual that these problems can be solved. Moreover, the canted roof directs rainwater into a large underground cistern that retains the water on site to help recharge the ground water, and enrich the soil for the surrounding landscape. Therefore, scientists can make most of the water to make experiment. In addition, it is vital for designers to take terrain factors into consideration. Many of the research buildings are set into the contours of gently sloping site. Hence, designers must have a second thought of the foundation. Certainly, most of research buildings are constructed on the flat plain.

### Diversity of Inner Functional Space

Research building has a wide variety of facilities, including labs, conference and meeting rooms, public spaces, exhibition space, restaurants,

科研建筑具有什么特征? 它们与其他建筑有什么不同? 科研建筑何以为科研建筑? 你将会在以下内容中找到答案。

总体来讲, 许多因素都对建筑的设计和施工有着重大的影响。此外, 科研建筑是我们工业社会知识密集型行业的代表, 在节能和环保方面需要更多的特殊设计。

### 充分利用当地的有利因素

科研建筑能够充分利用当地的地理因素。提到天气, 我们就会想到气温。许多科研建筑都位于相当炎热和日光充足的地点。俗话说, 有利必有弊。一方面, 设计团队利用光影的变化来进行植物学研究。另一方面, 为了应对极端气温和日照高温, 设计师必须采用新技术手段来降低室内温度。除了气温以外, 潮湿的气候也可以被利用。尽管高度潮湿的气候可能会导致不舒适的感觉, 设计师的聪明才智足以解决这些问题。此外, 倾斜的屋顶将饮水导入一个巨大的地下蓄水池, 能够保持水土并使其再次注入地下水, 并且丰富了周边景观的土壤。科学家可以充分利用水来进行实验。此外, 地形因素对设计师来说也至关重要。许多科研建筑被设在缓坡上。设计师必须仔细考虑地基问题。当然, 大多数科研建筑都建在平地上。

### 内部功能区的多样化

科研建筑拥有多种多样的设施, 包括实验室、会议室、公共空间、展览空间、餐厅、行政服务区和办公室。根据科研的类型, 科研建筑采用不同的布局。总体来讲, 地下室应该是停车场。一楼占据整个场地面积, 设置公共空间和门厅。研究