



MASSACHUSETTS GENERAL HOSPITAL, LUNDER BUILDING, BOSTON

马萨诸塞州综合医院，隆德大楼，波士顿

业主：Massachusetts General Hospital

地点：美国，波士顿

总建筑面积：530 000平方英尺

建筑设计：NBBJ建筑设计公司

建筑设计项目负责人：Timothy Johnson

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下一代医疗：为第三个百年而建

马萨诸塞州综合医院（MGH）建立于1811年，是美国历史第三久的医院，也是新英格兰地区最老和最大的医院。MGH因其在医疗、教育和研究方面的卓越成就而知名，在美国新闻与世界报道中一直名列全美医院前五名，并在2012年排名第一。

MGH每年服务近140万门诊病人，4.8万多住院病人。近年来，对门诊手术、急诊部就诊和急症护理住院病床的需求增长过快，超出了医院现有设施的承载力。因此，MGH决定将最初相对较小的住院设施规划（即1999年园区总体规划内的两栋新建筑之一）修改为能够容纳核心医院服务的较大设施。同时，MGH也将迎接其建院200周年，院方希望此新设施的开幕能作为其成立两百周年的庆典，同时引领医院的发展步入下一个世纪。院方决定在其波士顿市中心高密度的园区内建设一栋“为第三个百年而建”的新隆德大楼，营造出具有高科技和以病人为中心的治疗环境，以满足MGH当前的需求，并能与社区未来100年的需求一起成长。

Next-Generation Care: Building for the Third Century of MGH

Founded in 1811, Massachusetts General Hospital (MGH) is the third oldest hospital in the United States and the oldest and largest hospital in New England. Renowned for its excellence in medical care, education, and research, MGH is consistently ranked among the top five hospitals in the nation by U.S. News & World Report, and was Ranked NO.1 in 2012.

Serving nearly 1.4 million outpatients and discharging more than 48,000 patients annually, MGH needed to significantly expand its facilities in order to continue providing the quality care it's known for. Over the years, the demand for outpatient procedures, emergency department visits and acute care inpatient beds grew to far exceed the facilities of the hospital. This increased demand led MGH to alter its original plan for a smaller outpatient facility-which was one of two new buildings proposed in its 1999 Campus Master Plan-to build a larger facility that could house core hospital services.

MGH was also approaching its 200th year anniversary and saw the opening of this new facility as an opportunity to celebrate its bicentennial while advancing the hospital into its next century of care. The hospital decided to build a new addition to its extremely compact campus in downtown Boston, with a high-tech, patient-centered healing environment that could meet MGH's current needs and grow with the needs of the community for the next 100 years.



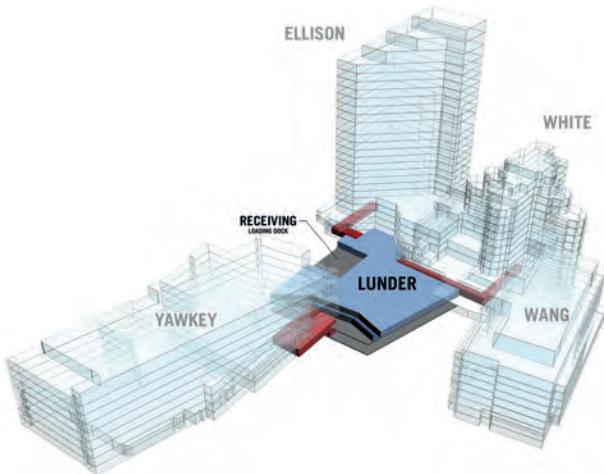
回应城市

建筑外部体量是内部功能的反映，5层的病房塔楼在视觉上与下方的手术楼层分离开来。建筑的外部则是对邻近的约基和怀特大楼的水平和垂直特性的一个回应，创建了一个与周边城市环境相协调的视觉语言。低层周围的玻璃翼片为里面的病人和员工提供了隐私，并减轻了外部建筑体量对行人的压迫感。在街面层，铺石路面、楼梯和顶篷为访客创建了一个独特的场所和通道，引导他们进入医院的主入口。

充分连接

作为美国最大的学术医疗中心之一，MGH显现了这些研究机构的许多典型特点：一个由许多不同年代建筑组成的紧密的城市园区，复杂的功能需求，设施和园区运营之间的高度协调和沟通。隆德大楼位于MGH园区的心脏地带，对其来说重要的是通过实现现有建筑之间的连接来协助整合教学、研究和病人治疗。

NBBJ使用动线建模来开发理想的连接方式，以使人们易于进入设施，病人转移到园区其他服务场所以及材料的物流等。由于现有建筑楼层间天花高度的限制，在人流和物流连接最为关键的地方不与5个楼层连接。



材料管理连接

上下货平台和无菌处理部分别位于地下一层和地下二层，并为整个园区提供服务。通过地下交通与怀特和埃里森大厦进行连接，这些连接对于园区范围内物流配送至关重要。

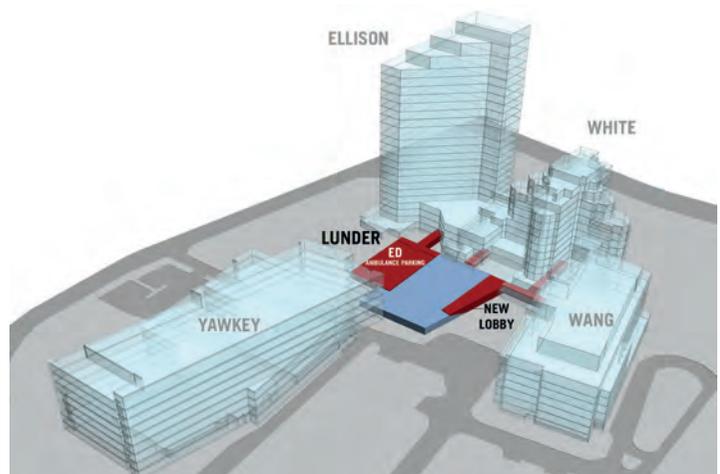
Urban Response

The massing of the building is a reflection of the program within, where the five-story bed tower is visually separated from the procedural floors below. The exterior of the building is a formal response to the horizontal and vertical nature of the adjacent Yawkey and White buildings, respectively-creating a visual language that fits with the surrounding urban context. Fritted fins along the lower levels provide privacy for patients and staff on the inside and help break down the exterior mass of the building for pedestrians below. At street level, a paved walkway, stairs, and a canopy create a distinct place and pathway for visitors, directing them to the hospital's main entrance.

Well Connected

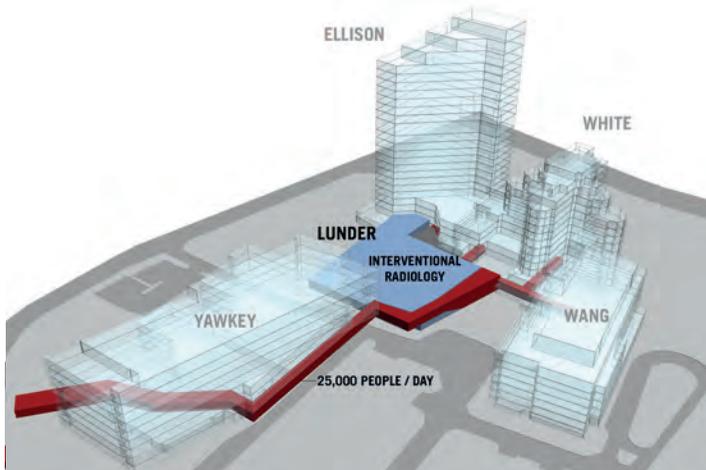
As one of America's largest academic medical centers, MGH exhibits many characteristics that typify these institutions—a tight, urban campus comprised of many buildings from different eras, complex programmatic demands, and the need for high-level coordination and communication between facilities and campus operations. Located at the heart of the MGH campus, it was critical that the Lunder Building facilitate the integration of teaching, research, and patient care by enabling connections between existing buildings.

NBBJ used circulation modeling to develop the ideal connections for ease of facility access, patient transport to services elsewhere on campus, and materials flow. Due to constrictive floor-to-floor ceiling heights within existing buildings, the decision was made to limit connections to five floors, where pedestrian traffic and logistical connections to existing buildings were most critical.



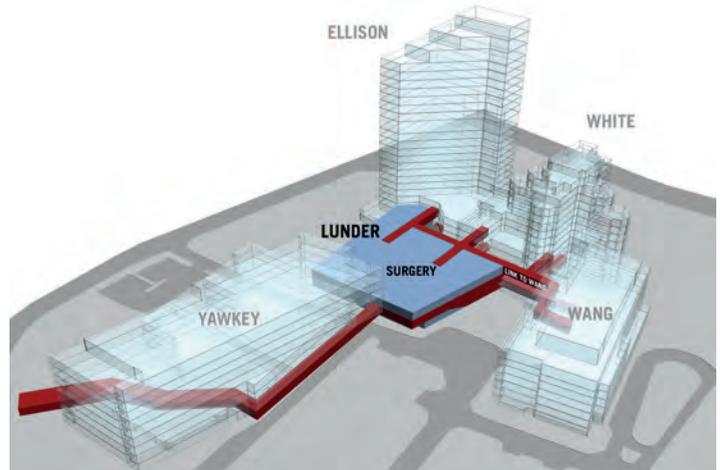
急诊部连接

除新大厅连接到怀特大楼入口之外，首层还提供了一个新的急诊部，完美连接怀特大楼现有的急诊部，实现了整个急诊部的分期建设。



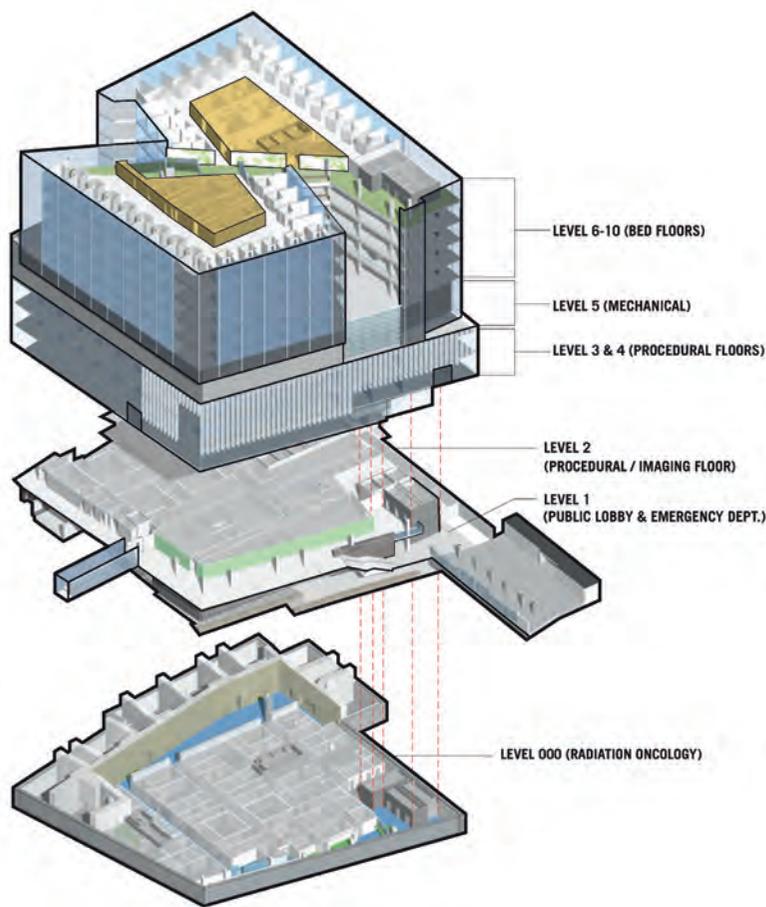
二层走廊连接

每天都有25,000人到达Charles/MGH T车站并穿过约基楼和隆德大楼的第二层走廊进入MGH园区的其他部分。

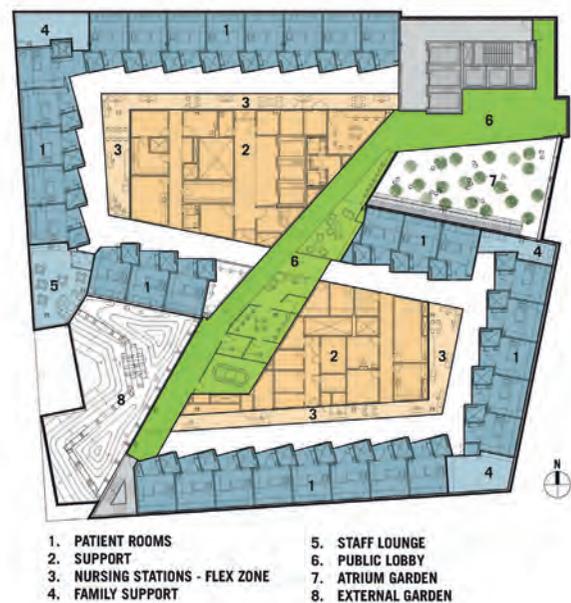


手术室连接

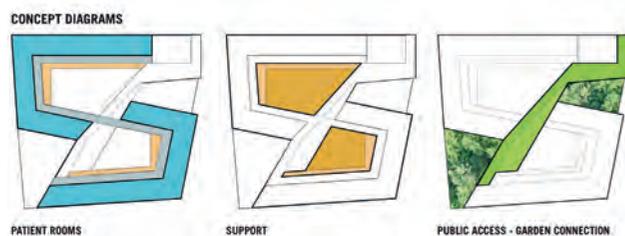
第三层的连接提供了直接进入怀特、埃里森和王氏大楼的通道。所有接受手术的病人在王氏大楼登记并进行术前准备，然后被转移到隆德或怀特大楼进行手术。手术之后，门诊病人通过王氏大楼离开，住院病人被带至兰德大楼或园区其他地方的恢复室。



整体功能布局分析



病房楼标准平面



病房楼平面布局分析

管理的复杂性

隆德大楼是一个极为复杂的建筑，不仅与园区现有基础设施进行外部连接，而且在内部也连接了大量不同的功能元素。这栋14层的建筑容纳了5层的病房集中区、高科技手术楼层、一个急诊部、收货区、无菌处理部、处理部门、新急诊和射线肿瘤单元。其挑战在于最大程度地实现未来使用灵活性和减少对园区其他地方的干扰，并将各式各样的功能堆叠到极度紧凑的场地上。

设计工具：建筑信息模型

设计团队采用了三维建筑信息模型（BIM）来驾驭场地的复杂性，以在设计阶段探索功能组合形式。3D工作模型可帮助每个设计团队成员在设计过程中针对专业的细节层层深入，确保大楼所有的组成元素和连接均与场地相适应，并能发挥功用。嵌入的“冲突检测”系统用于发现早期问题以及在开始施工之前检测解决方案的可行性。

3D模型用于开发建筑的核心元素，包括建筑、室内、规划意图、结构、机械和电气系统。BIM也是一个沟通工具，如与建筑使用者分享想法，获得市政批准，演示施工如何分期而避免现场问题。

打破场地限制

项目任务书中明确说明需要更多的病床以满足住院病人数量的增加和从双人病房向单人病房的转变，以有益于预防感染、保护隐私，实现更多以病人/家庭为中心的治疗。然而，增加更多的单人病房通常会增加楼层面积，导致护士的移动距离增加，也将分离需要紧密合作的医疗工作者。场地限制和病房楼层楼面面积的增加，让为每

Managing Complexity

The Lunder Building is an incredibly complex building that not only makes external connections to existing infrastructure on campus, but also internally links a number of different programmatic elements. The 14-story building houses a five-story patient tower, high-tech procedural floors, an emergency department, receiving dock, a sterile processing department, a processing department, a five-story patient tower, and new emergency and radiation oncology units. The challenge was to stack this varied program onto an extremely compact site in a way that would maximize future flexibility and minimize disruption to the hospital's services elsewhere on campus.

Design Tool: Building Information Modeling

The design team employed Building Information Modeling (BIM) technologies to navigate the complexity of the site and explore program alternatives during the design and documentation phases. A working 3D model was created enabling each design team member to layer in trade-specific details as the design progressed, to ensure that all of the building's components and connections fit and worked within the site. Built-in "collision detection" systems allowed for the early identification of problems and their solutions prior to the start of construction. The 3D model was used to develop core elements of the building, including architecture; interiors; planning intent; and structural, mechanical, and electrical systems. BIM was also used as a communication tool for sharing ideas with the building's users, obtaining city approvals, and demonstrating how construction was being phased to avoid on-site complications.

Breaking Site Constraints

The project brief specified a need for more beds to meet increases in patient volume and a shift from double to single patient rooms for the benefit of infection prevention, privacy, and greater patient/family-centered care. However, adding more single rooms typically increases the size of the floor plate, which increases travel distances for nurses, and further



内部庭院

个人提供阳光的接触变得具有挑战性，但这是新建筑的一个主要设计目标。

NBBJ设计了多种方案，确保最大程度增加日光和每层病床数量，同时最大程度减少员工的移动距离。一个大的“突破”是打破和转动楼面以分开护士站点，创建一个对角穿越楼面的中央动线主轴。主轴创建了一个室内中庭和外部花园的直接连接，优化了导向，使得光线能够深入建筑的核心区。

与其创建一个沿着周围和中央护士站的矩形环线型病房分布，不如实现两个互锁的C形病床组，最终使得每层能有更多的病房，增加了医疗连接，并最大程度地减少了员工行走至病房、中央供应区和支持区的距离。

强化病人的安全感和满意度

众所周知，与户外和自然光线的接触可以加速恢复和疗愈过程，增加病人、家属和员工的满意度。透过自然光照亮的空间也可减低对电能的依赖，带来运营和可持续性方面的好处。主要的设计目标是让自然光线尽可能地深入空间，并提供花园和波士顿都市风光的景观。病房拥有落地窗、一个五层楼高的花园中庭、外部的竹园，这些设计将日光带入病房楼层深处，为建筑核心区周围的房间提供自然光线和与户外景观的接触机会。

病房的设计中还采用了以下几种措施来为病人、家属和员工提供最大的舒适度和安全性。个人防护设备柜位于每间房间的外面，

separates clinical collaborators who work in close proximity to one another. Site constraints and the square floor plate of the patient tower also made it challenging to provide everyone access to daylight, which was a major design goal for the new building.

NBBJ developed numerous options for maximizing daylight and the number of patient beds per floor while minimizing travel distances for staff. The big “aha” was in fracturing and shifting the floor plate to break apart the nursing pods and create a central circulation spine that traverses the floor plate diagonally. The spine creates a direct link between an interior atrium and exterior garden, improves wayfinding, and allows daylight deep into the core of the building.

Rather than creating a square loop of patient rooms along the perimeter and a central nursing core, the resulting plan yields two interlocking c-shaped groups of beds which allows for more rooms per floor; increases clinical connection; and minimizes staff travel times to patient rooms, central supply, and support areas.

Enhancing Patient Safety and Satisfaction

A connection to the outdoors and natural light is known to speed up the healing process and increase patient, family, and staff satisfaction. Naturally lit spaces also have operational and sustainable benefits by decreasing reliance on electrical energy. A major design goal was to bring daylight as deep into the space as possible and provide views to gardens and the Boston cityscape. Patient rooms feature full-height windows, and a five-story garden atrium and exterior bamboo garden bring daylight deep into the patient tower, providing rooms along the core of the building access to natural light and views to the outdoors.

Several measures were taken in the design of the patient rooms to provide patients, family, and staff with maximum comfort and safety. Personal protection equipment cabinets are located outside each room for convenient point-of-use access to gloves, masks, and gowns; a five-foot-wide entrance



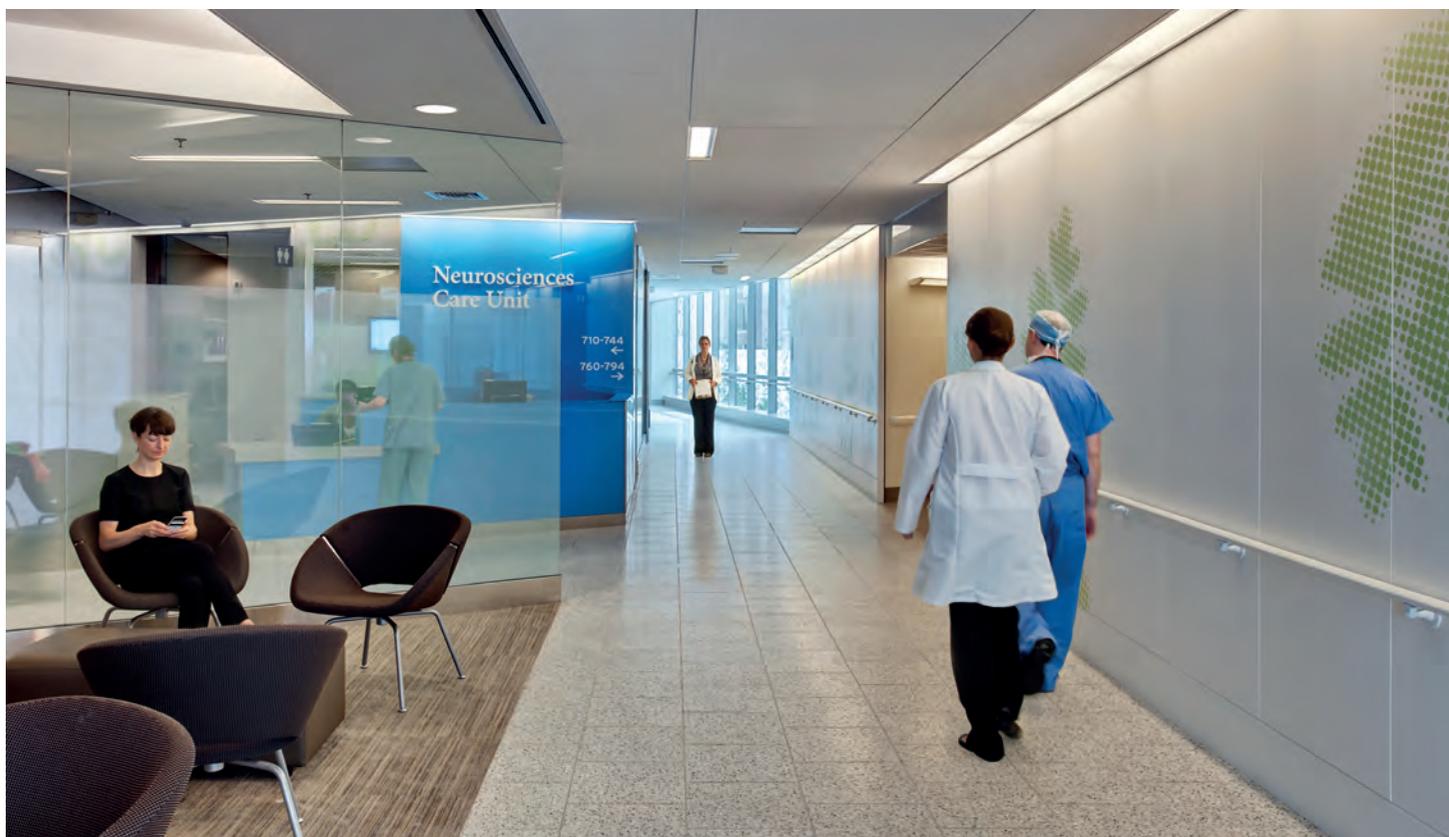
首层平面图



二层平面图



四层平面图



走廊及休息区



走廊



分类/登记区

以便于手套、面罩和衣服的就地使用；一个带滑动玻璃门的五英尺宽入口能使进出便捷和提高能见度；一个面对病人的护理人员工作站可以保证病人在视线中，并同时更新记录；一个带内部夜光的半透明卫生间可方便夜间导向；一个病人用升降机可在病床到卫生间的范围内操作，以帮助护士运送不能行走的病人。

宁静的走廊

噪声是美国住院病人抱怨最多的项目之一，它会使得血压升高、干扰睡眠、增加疼痛的敏感度和压力。NBBJ采用多种策略的组合来降低整个建筑的噪音。电梯、公共等待区和员工会议室分布于中央动线主轴，远离病房。分散的“互动区”避免护士和医生聚集在一个主要的护士站，而支持和服务区则隐藏在远离主走廊的地方。橡胶地板和吸音吊顶对移动和絮语的声音进行缓冲。病房的大型滑动玻璃门提供了更高的能见度并使得自然光能够进入走廊，而同时将噪声关在门外。MGH根据医院消费者评估调查表发现隆德病房的安静度提高了6个以上的百分点。

灵活的设备平台

第四层容纳了一些最为先进的医学科技设备，包括两间使用Zeego机器人设备的混合手术室和一间术中核磁共振手术套间（安装在天花板轨道上可在两个相邻手术室内移动）。混合手术室的特色是成像系统，能捕捉之前在导管和开发病例中较难的有利位置。射线可透的手术台可在标准手术时与传统手术台互换，为每个手术室实现双倍功能。

术中核磁共振手术套间并不是原始规划的一部分，而是在施工规划过程中因有越来越多的先进核磁共振设备的出现而进入规划的。NBBJ对第四层的平面布局进行了重新设计，通过将现有的一个手术室与核磁共振区合并来适配新的三个房间的套间，同时重新安排卫生间和部分储藏空间的位置。

术中核磁共振手术套间的设计要求一丝不苟的规划。18 000磅重的成像设备的磁场强度超过地球磁场60 000倍，因此磁体必须进行屏蔽，避免与钢柱、梁和变压器的接触。为了保持磁力和避免干扰，用铜和硅钢在所有墙面、天花和楼板上形成连续屏障。地板上的同心椭圆标明磁体吸力的等级，确保在磁体进入房间时手术器械和其他金属物品可保持在适当的距离。天花吊杆使安装的灯具和设备能够轻易地移出位置。

with a sliding glass door enables ease of entry and greater visibility; a caregiver work station faces patients so records can be updated while keeping the patient in sight; a semi-opaque toilet room door with a nightlight inside eases wayfinding in the dark; and a patient lift operates from the bed to the toilet room to help nurses transport patients who are unable to walk.

Quiet in the Halls

Noise is one of the top complaints of hospitalized patients in the United States and can raise blood pressure, interrupt sleep, increase sensitivity to pain, and raise stress levels. NBBJ employed a combination of strategies to reduce noise throughout the building. Elevators, public waiting areas, and staff meeting rooms are located along the central circulation spine away from the patient rooms. Dispersed “interaction zones” prevent nurses and clinicians from congregating at one main nursing station, while support and service areas are tucked away off the main corridor. Rubber flooring and acoustical ceiling tiles buffer the sound of movement and chatter. Large, sliding glass doors to patient rooms provide greater visibility and allow natural light to enter the corridors, while keeping the noise out when closed. Using a standardized Hospital Consumer Assessment survey, MGH has seen increases of six percentage points and higher on the quietness questions for the Lunder patient units.

A Flexible Platform for Future Practice

The fourth floor houses some of the most progressive medical technologies available, including two intraoperative hybrid ORs using Zeego equipment (image upper left) and an OR suite using an intraoperative magnetic resonance imaging (IMRI) device mounted on a ceiling track that can move between two adjacent operating rooms (image upper right). The hybrid rooms feature an imaging system that captures previously difficult vantage points during procedures for both catheter and open cases. A radiolucent operating table can be interchanged with a traditional operating table for standard procedures, doubling the functionality of each room.

The IMRI suite, which was not part of the original plans, came online during construction planning as more advanced MRI devices became available. NBBJ redesigned the fourth floor to fit the new three-room suite by incorporating one of the existing ORs with an adjacent MRI bay, and relocating a restroom and some storage space.

The design of the suite required meticulous planning. The 18,000 pound imaging device has a magnetic field 60,000 times more powerful than the Earth's, so the magnet had to be shielded from steel columns, beams, and electrical transformers. To contain the magnet's forces and keep interferences out, copper and silicon steel make up a continuous barrier behind all wall surfaces, the ceiling, and floors to create this shield. Concentric ovals on the floor mark the levels of the magnet's pull, ensuring that operating instruments and other metal items are kept at a proper distance when the magnet is brought into the room. Ceiling booms allow mounted lights and equipment to be easily moved out of the way.



在最新科技出现之前，用于将MRI（核磁共振）运送进出大楼的走廊原先设计有较大的梁和更多的钢筋来承受IMRI的重量。在走廊一端的外墙采用模块化的建造方式，这样在安装和未来替换时可借助外墙将设备吊起而灵活移动。

减少等待时间

隆德急诊部（ED）新建部分提供了17 500平方英尺的扩建空间，包括自行就诊病人的新病人登记和分类区、急症适应筛选和急症区、外伤治疗室、有毒物质净化区和封闭式救护车车库。作为提高医院急症服务的更大规划的一部分，将这些服务转至隆德大楼可使得现有怀特和埃里森大楼内的急诊空间进行分期的整修。

新的急诊部也支持MGH在现有急诊部试行的分流过程。其目标是通过将最为严重的病人与症状较轻的病人相分离的方式来减少病人等待时间和“无治疗即离开”的情况。自行就诊的病人到达一个充满光线和景观的空间，由迎宾护士迎接并进行即时评估，再将最严重的病人送至病床，或将儿童病人送至儿童急诊部。在迎宾护士之后是五个玻璃围护的分类/登记区，使护士可以对症状较轻的病人进行快速登记和检查重要信息，这些病人随后被送至筛查室，医生在此进行进一步的诊断分类，然后根据病人的不同情况送至观察、直接治疗或到医院病房。

通过救护车到达的病人在一个单独的担架分类区进行评估。分类员工工作区可以看到救护车停车区和自行就诊区，它是观察和帮助担架病人和自行就诊病人的中枢。最终的效果是等待时间减少，重症病人救治更快，在保护病人隐私的同时使员工的可见度增大。

优化病人和员工的就诊体验

位于地下三层和地下四层的克拉克放射肿瘤中心集合了柔和灯光、自然装修、花园主题图案、开放和私密空间，为病人和员工营造一种平静感。这里拥有放射治疗的最新技术，为初诊和复诊病人提供了舒适的环境。该中心占据两层楼，为初诊和复诊病人提供了不同的入口。

初诊病人进入与门诊治疗区分开的上层。复诊病人则从一个双层接待休息室进入下层，随后通过充满艺术气息的走廊进入更衣室。靠近治疗室的另一个等候休息室可提供成组座位以供交流，或

In advance of the latest technology, the hallway that was used to transport the MRI in and out of the building was designed with larger beams and more reinforcing steel to withstand the load of the IMRI machine. The exterior wall at one end of the corridor was built in a modular fashion so it could be easily removed to hoist new equipment through the wall during installation and for future replacement.

Decreased Wait Times

The Lunder Emergency Department (ED) addition provides 17,500 square feet of expanded space, which includes new patient registration and triage bays for walk-ins; acuity-adaptable screening and acute areas; trauma rooms; a hazardous materials decontamination area; and an enclosed ambulance garage. As part of a larger plan to increase emergency services at the hospital, transitioning these services to the Lunder Building allowed existing ED spaces in the White and Ellison buildings to undergo phased renovations.

The new ED also supports a split-flow process that MGH piloted in their existing ED. The goal is to cut long patient wait times and “leaves without treatment” by separating the flow of the sickest patients from those who are less sick. Walk-in patients arrive at a space filled with light and views and are met by a greeter nurse who does an immediate assessment and sends the sickest patients to a bed and pediatric patients to the pediatric ED. Beyond the greeter nurse are five glass-enclosed triage/registration bays that allow nurses to quickly register and check vital signs for the less-sick patients, who are then sent to a screening room where a physician conducts an extended diagnostic triage. From there, patients can be sent for post-screening follow-up, directly for treatment, or to a hospital bed.

Patients arriving by ambulance are assessed in a separate stretcher triage area. The triage staff work area, which has views to the ambulance bay and the walk-in area, is the hub that observes and supports both the stretcher and walk-in patients. The final result is decreased wait times, quicker care for sicker patients, and greater visibility for staff while also providing patient privacy.

Improving the Patient and Staff Experience

Located three and four stories below grade, the Clark Center for Radiation Oncology incorporates soft lighting, natural finishes, garden-themed graphics, and both open and intimate spaces to create a sense of calm for patients and staff. The new Center houses the latest technology in radiation therapy and is designed for the comfort of both new and returning patients. The Center occupies two levels, and provides separate entries for new and returning patients.

New patients, arriving for their first consultation, enter on the upper floor separate from any clinical or treatment activity. Returning patients arrive on the lower level, where their routine path of travel begins with a two-story receiving lounge, then an art-filled corridor that leads to the dressing rooms. Another waiting lounge near the treatment rooms offers clustered seating for social interaction, or lounge chairs and bamboo banquettes for more privacy.



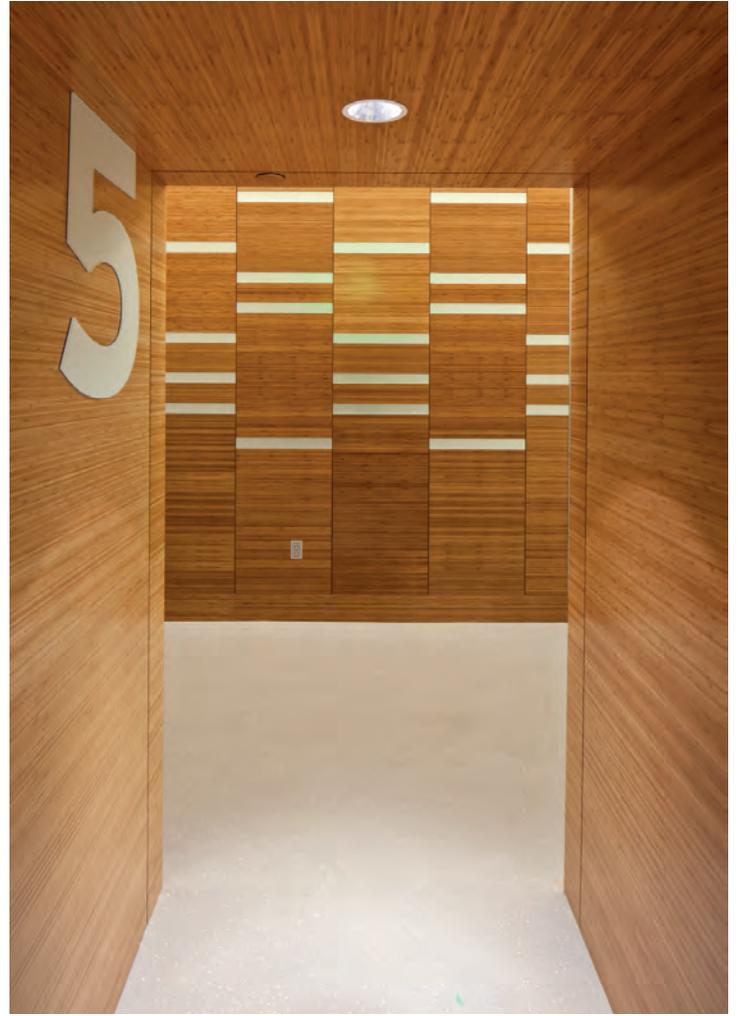
普通病房



加护病房



外部玻璃幕墙



室内环保材料

提供更具私密性的沙发椅和竹椅。通过担架床到达的住院病人有一个进入治疗室的私密入口，无需通过较开放的公众空间。在等待休息室边上有个小房间，病人可以私下向护理人员进行咨询。

直达细节的设计

功能平面图示是隆德大楼内的总体验中整体的一部分，强化MGH品牌和统一内部的多个部门和空间。本地植物的抽象图示贯彻在每个楼层的花园主题中，从大规模的墙面图像到窗帘和家具的细节，统一而醒目的标识和MGH品牌形象的蓝色使用于整个大楼中，帮助访客和病人导向和定位。

绿色与健康

隆德大楼获得LEED NC黄金级认证，其可持续性设计强化了这座建筑的美学、体验和效率。外部玻璃幕墙系统最大程度地减少了吸热和散热，同时使日光能够进入内部。加强型的通风系统维持清洁健康空气的持续供应。建造中使用的材料超过三分之一是回收利用材料或者当地材料，室内装饰使用的是可再生材料。安装低水量卫生洁具，每年可减少用水量达140万加仑（20%）。雨水收集系统和空调冷凝水的利用消除了使用饮用水灌溉植物的情况。绿色植物的覆盖超过了一半的建筑区域。运货车和救护车进入到隆德大楼的核心区，让噪声和活动远离邻近的街区。（译/严佳钰，校/张洁）

Inpatients arriving by stretcher have a private entry into the treatment room without having to pass through the more public areas. Small rooms are available immediately off the waiting lounge so that patients can consult with their caregivers in private.

Designed, Down to the Details

The environmental graphics program is integral to the overall experience of being inside the Lunder Building, reinforcing the MGH brand and unifying the multiple departments and spaces within. Abstracted images of local foliage carry through the garden theme on each floor—from large-scale wall graphics to curtain and furniture details. Consistent, clear signage and the MGH branded blue are used throughout the building to assist visitors and patients with wayfinding and orientation.

Green and Healthy

The Lunder Building is LEED NC Gold certified, and features sustainability measures that add to the aesthetics, experience, and efficiency of the building. The exterior glazing system minimizes heat gain and loss while allowing daylight to enter. An enhanced ventilation system maintains a constant supply of clean, healthy air. More than one-third of the materials used for construction were recycled or locally extracted or manufactured materials. Renewable materials were used for interior finishes. Low-flow plumbing fixtures were installed to reduce water consumption by 1.4 million gallons per year (20%). To eliminate the use of potable water for plant irrigation, systems capture rainwater and air cooling condensate for irrigation. Greenery covers more than half of the building's footprint area. Delivery trucks and ambulances enter through the Lunder Building core to keep noise and activity off neighborhood streets. 