The Building Arts in the Service of Librarianship *

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I.

No PUBLIC institution appears to have suffered as much as the library from a lag between need and condition, between the requirements of its users and its staff, and the immediate likelihood of satisfying them. The public or private library, whether it serves a community, a university, or the nation, seems to be chronically ill-housed and ill-fed: there is never enough space, enough light, a large enough staff and collection, and of course, enough money. There are social and historical reasons for this state of affairs. We usually treat our cultural institutions as unwanted stepchildren who must take second place to the demands of commerce and entertainment, so that the library often finds itself in the same embarrassing position as the art museum, the symphony orchestra, and the opera company. In the history of modern building art, the library was nearly the last element of the community to be the object of a systematic investigation of its social role and its functional character, a condition which it shared with the school, the theater, and the museum. For these reasons, the construction of a new library is always an important event, and the occasion we have met to celebrate is something of a triumph. Indeed, the design and construction of libraries constitute a microcosm of the whole building art in the Industrial Age—its fundamental technical, architectural, and social problems, and the development of progressively more adequate solutions.

I should like to use the opportunity to make the new National Library of Medicine the focus of a broad historical inquiry: to examine the background need, to describe the genesis and the construction of the building, and to show the number of architectural events during the past century that converge on this structure.

The old Army Medical Library was built in 1885–87, just twenty years after John Shaw Billings had taken over the management of the Library

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of the Surgeon General's office. Since he had pointed out the need as recently as 1880, we may regard the construction of the building as further evidence of his capacity for translating ideas into practical reality. At the time the largest library in the United States housed 250,000 volumes, a fact which makes us realize that the rapidly expanding Medical Library would soon reach the limit of its capacity and by implication test the architect's ingenuity to the utmost. By 1896 shelf space was so cramped that the librarian had to request an appropriation for additional stacks and to repeat the request a decade later, by which date he received 60 per cent of what he asked for.

In 1916 the Surgeon General urged that only a new library building would solve the growing problem. World War I, the inertia of a decade hardly noted for its civic responsibility, and the depression of the thirties held up action for more than twenty years. In 1938 the Congress authorized money for preliminary planning but war again prevented further action on the part of the Federal Government. In spite of the exigencies of World War II, however, a survey of the Library's needs was undertaken in 1943–44 under the sponsorship of the Rockefeller Foundation. In 1955 the second Hoover Commission proposed that the Library be transferred to another department of the Cabinet and that it be given the name it now has. From then on events moved with relative rapidity: the Congress voted the necessary legislation in 1956; the contract with the architects was signed in 1957; the appropriation for construction was voted in 1958; and the building was constructed in 1959–62. By the time of planning the requirements had grown to storage for 1,100,000 volumes and work space for 250 people engaged in an unusual variety of tasks. The structure and its internal divisions were the creation of the architectural firm of O'Connor and Kilham and the engineers Severud, Elstad and Krueger, but their achievement would have been impossible without the practical and detailed advice of the Director of the Library, his Executive Officer, and their colleagues.

The $7,000,000 library building offers a complex example of the functional approach to contemporary architectural design. Such planning may be characterized as beginning at the inside with the focal area and its function and progressing step by step to the external envelope of the building—internal divisions and structure, utilities, walls, landscaping, broadly in that order. The initial step was the establishment of those principal functions which had to be located together on the main floor, at the finished grade level. After a series of trials, it was concluded that this area would require 55,000 square feet. The main floor area roughly determined the horizontal dimensions of the building, and also the number of levels required to accommodate the total area and the various functional elements.

With the overall plan of the building fixed the preparation of the site

then had to be faced. Since 165,000 square feet, or two-thirds, of the total floor area are below grade, drainage was an all-important consideration. The topography of the site appeared to be ideal for gravity drainage, and the architects and engineers were able to achieve it for all the net floor area except for the enclosure housing the mechanical utilities. Below the low drainage level, the floor of this deep-lying room must be drained by pumps. Excavation is a problem that ordinarily concerns only the contractor, once the engineers have completed the topographic survey, but the disposal of spoil is a problem which may offer the architect an opportunity. In this case he planned a raised and leveled terrace to surround the building, to set it off and give it a certain eminence which helps to counteract the tendency of long, low buildings to recede into the horizon. The terrace required the backfilling and grading of a large proportion of the excavated material. The landscaping of this terrace was the last step in the architects' designing responsibility.

In a large modern building, however, the final product may be as much the work of structural and mechanical engineers as it is of the architect. This is especially the case where peculiar exigencies require deviations from one standard and well tested structural system. The Medical Library, as a matter of fact, embodies the three basic structural techniques of contemporary large-scale building: the steel frame; the reinforced concrete frame, and the concrete shell (the last is sometimes designated as a continuous form to distinguish it from the jointed or articulated forms of the frame).

Before detailed structural planning was undertaken the architects and engineers had first to determine a basic module as the guide to the most efficient way of housing stacks, offices, and service facilities. Since the square bay is the simplest and most practical form, they decided on a span of 21 feet in both directions for the framing of that part of the building lying below grade, primarily because this dimension best accommodated the stack system, allowing for standard 3-foot units spaced 50 inches on centers. For the load-bearing structure the most economical, flexible, and fireproof system is the column and flat slab of reinforced concrete. In this system the floor slab rests directly on the columns rather than on the intermediate grid of girders, beams, and joists, which seriously restrict overhead clearance. The engineers treated the stack levels as loft space with 10½-inch floor slabs reinforced in two directions for a load of 125 pounds per square foot.

With the need to keep excavated volume to a minimum and with high unit loading, the slab system and the relatively modest bay span represented the natural choice for the stack area. Above grade, however, with a more generous allotment of space and smaller loads, the engineers could use the conventional steel frame of columns and girders to carry the floor

and roof loads. Varied use of space on the main floor, such as reading, lobby, and catalog areas, suggested a departure from the uniform bays of the stack area. On this floor the basic module is expanded into multiples with an intermediate span of 42 feet and a maximum of 63 feet. The last figure is approximately the dimension of the square enclosing the public catalog.

Standing above the mezzanine roof and located over the public catalog is the most striking feature of the building, the clerestory surmounted by a shell in the form of a hyperbolic paraboloid. The total area of this shell is 9,500 square feet and its clear span 98 feet; yet it supports itself and its wind and snow load with a thickness of only three inches, exclusive of the stiffening ribs at the outer edges and interior valleys. A shell of this kind represents the latest, the most efficient, and the most spectacular of modern structural forms for roofing large open areas. The warped surface is a rigid structure: it supports itself and will not bend downward because of the vault-like action of its doubly curved surface. Additional strength was imparted to the thin shell by the process known as prestressing. This was the most dramatic operation in the construction of the building. After the concrete had set, jacks located on the mezzanine floor forced the columns supporting the four corners of the shell outward. Since the columns are hinged at the mezzanine roof, they pivoted around the hinges and the lengths above the roof thus moved inward. A movement of no more than three quarters of an inch squeezed the roof along its diagonals, lifted it off the formwork, and held it tight and rigid in a slightly bowed-up position. The sprung curve of the barrel stave offers a parallel example from among our commonplace experiences.

Returning to the process of design, we may say that only after all functional planning, structural design, and location of utilities are complete do the architects turn to the formal or aesthetic end of their work. The visual quality of the building literally grows organically out of its empirical form. In a spatial sense, the all-embracing formal idea grows progressively outward from the catalog space as the central focus and dominant feature. The result is the simplest geometric figure enclosing the functional complex: the main block is a rectangular prism whose patterned limestone envelope is broken only by the entrance and the narrow light slots; above it the smaller block of the mezzanine is marked by a vertical pattern of narrow windows; capping the whole is the outward-leaning clerestory under its hyperbolic-paraboloidal roof. The whole rises as a series of steps surmounted by the lightly poised undulating shell. This movement can be seen properly only at a distance sufficient to bring out the mezzanine block, which provides the transition from the main block to the clerestory. Without this transition the curved and flaring roof would seem unrelated to the underlying mass. The primary aim in the design of the library was to

achieve simplicity and rhythm by interrupting the dominant horizontal motif with a subdued vertical pattern. The geometric horizontality will be simultaneously relieved and enhanced by a landscaping of low shrubs and flowering trees.

II.

Planning and construction on the sophisticated level of the Medical Library do not spring full-grown from the heads of their creators. They are, indeed, the products of long and intricate developments in the art and science of building. I have already suggested that the library itself constitutes a microcosm of the main architectural and structural problem of the Industrial Age, a problem which we can hardly claim to have solved in all its dimensions today. As a consequence, the Medical Library building may be seen not only as an achievement of contemporary building art, but equally as the focus of a number of evolutionary currents of the past century and a half. The great fundamental developments I shall treat only in the briefest and most general way. Within this framework I should like to concentrate on concrete events in library planning to show how crucial the library proved to be in the historical pattern.

To do this properly we must first recapitulate the dominant characteristics of building in our mechanized industrial culture. Serious architecture in the nineteenth century was marked by a succession of revivals—Greek, Gothic, Romanesque, Renaissance—which generally required that the architect start with a formal idea derived from the past and then proceed to plan the details of his building within the exigencies imposed by that form. Questions of use, lighting, ventilation, and siting frequently had to be regarded as secondary to the organization of exterior form. However beautiful and well designed individual buildings might become in the hands of creative men, however well they reflected the true spirit of the age, there is no question that the derivative approach increasingly hampered the architect and by the end of the century came to stand at odds with functional needs and the structural possibilities available to him. We might summarize the demands placed upon him as follows: (1) the development of new structural techniques derived from the new materials of iron, steel, and concrete; (2) the use of these techniques to serve the often unprecedented requirements of new kinds of commercial and public buildings; (3) the careful investigation of functional needs and the recognition of them as serious architectural determinants; and (4) the creation of a style growing organically out of response to the new technology and the associated urban world.

The evolution of this realistic approach to architecture began with vernacular industrial building in England around 1800, when iron first came to be used extensively for the interior columns and beams of factories and

warehouses with masonry walls. Step by step the system evolved into the steel skeleton and the curtain wall of the modern skyscraper in Chicago around 1890. During the early iron-and-masonry phase of this development the library soon came to play an important role because the building posed the difficult problem of combining large unencumbered interior space with strongly framed stack areas. The first systematic and successful attempt to deal adequately with these requirements came from the French architect-engineer Henri Labrouste. In the Bibliothèque Ste. Geneviève, Paris, 1843–50, he designed the first monumental public building supported by a cast and wrought iron interior frame in conjunction with exterior masonry walls. The reading room is the most remarkable feature: its ceiling consists of two parallel vaults carried by the outer walls and an intermediate row of cast iron columns, the plasterwork of the vault itself supported by a light framework of wrought iron ribs.

Labrouste's triumph and an epoch-making work of nineteenth century building art is the Bibliothèque Nationale in Paris, constructed in 1858–68. Here the reading room is square, with a multiple-dome, iron-framed ceiling carried on 16 cast iron columns. But it is the stacks that attest to the full measure of Labrouste's ingenuity: for the first time this element of the library was designed on a thoroughly functional basis. He regarded the stack area as the real heart of the library, storage space for 900,000 volumes to be housed in a skyscraper of the day, with four stories above ground and one below. The enclosure was treated as a separate structure supported by a frame of cast iron columns and wrought iron beams. The floors and stair treads were composed of panels of open cast iron grids to allow light from the skylight to penetrate through all stack levels. This masterpiece of structural art was wholly free from traditional monumentalism—a license the architect allowed himself because it was closed to the public! It was well into the twentieth century before Continental library design was again to reach a comparable level.

The functional approach to library design began very modestly in the United States with the small public library at North Easton, Massachusetts (1881), and the Crane Library at Quincy, Massachusetts (1883). Both were designed by Henry Hobson Richardson, who here revealed the direct approach and the refinement of Romanesque forms that made his big buildings point toward the new commercial style then beginning to develop in Chicago. In little more than a decade the archetypes of the great public libraries were to be constructed—Boston, 1888–92, designed by McKim, Mead and White, and Chicago, 1893–97, the work of Shepley, Rutan and Coolidge. But in these buildings the lessons of Labrouste and Richardson were imperfectly heeded. They are impressive examples of Renaissance Revival architecture, but they are marked by serious functional errors and by a costly waste of space. As the historians Burchard and Bush-Brown

wrote, "While Boston's Public Library could hardly be outdone within the premises of Renaissance design, its excellence of form did not prevent readers from discouragement and librarians from outright criticism."[1] And although Chicago had achieved steel-framed skyscraper construction by 1890, both the Chicago and Boston libraries relied on the combination of the traditional masonry-bearing wall and the inner iron frame for their structural bases. This was the time of the old Army Medical Library (1885–87), a building which seems curiously antiquated beside its celebrated contemporaries; yet its structural system is not much different from that of the larger and more elegant buildings.

The situation had reached the point where the librarians began to feel highly dissatisfied and to raise their voices in protest. In 1891 C. C. Soule, writing in the *Library Journal*, launched an attack with the bald statement that the architect is the librarian's worst enemy. He and others demanded that the library should be planned for economic and efficient administration, convenience of arrangement for staff and readers, avoidance of wasted time in providing normal library services, ample natural light, simple decoration easy to clean, separation of reading areas from stacks for easy expansion of the latter, for the reading, storage, and administrative needs at the time with the spatial and structural means for future enlargement. It was the manifesto of the new program of library design, and one would suppose that it would have led to an immediate effect, but the librarians were destined to suffer further disappointments.

There was one notable exception to the ruling fashion, one of the few that helped to maintain the precarious continuity that unites Labrouste's work to that of our own day. In 1895 the Astor, Lenox, and Tilden libraries of New York were merged into a single unit, and the city donated land at Fifth Avenue and 42nd Street—the site of the old Croton distributing reservoir—to establish the consolidation as the New York Public Library. A national competition for the design of the building was held in 1897 and won by the architectural firm of Carrère and Hastings. The architects sought the advice of John Shaw Billings, newly appointed Director following his thirty-year tenure in the Surgeon General's Office as Medical Librarian. What is not realized, however, is that Billings could speak with some authority on architecture. In 1873, when Johns Hopkins endowed the hospital in Baltimore that bears his name, he personally wrote to Billings asking for advice in planning a hospital building to provide adequate "ventilation and heating and light and sunshine, as curative agents."[2] The structure as finally built in 1888 was Billings' creation—

[1] BURCHARD, JOHN, AND BUSH-BROWN, ALBERT. Architecture in America; a Social and Cultural History. Boston and Toronto, Little, Brown & Co., 1961. p. 280.

[2] Letter from Johns Hopkins to John Shaw Billings, 1873; quoted in Burchard and Bush-Brown, *op. cit.*, p. 181.

architecturally most undistinguished, but functionally far superior to any other hospital of the time.

In the New York library Billings provided overall planning sketches indicating the disposition of the various facilities and enclosures, advised the architects during the preparation of detailed plans and during construction, then put his own program to the pragmatic test by supervising the reclassification, recataloging, and reshelving of the books of the original three libraries. The building itself, completed in 1906, is of French Renaissance design, but Hastings took some pride in the skyscraper verticalism of the rear wall, which reflects the structural pattern of the stack tiers.

The story of library construction in the first third of the present century is one of rapidly growing numbers and increasing size, in which the steadily advancing techniques of steel and concrete framing and caisson foundations were applied to the structural problems. But the major public libraries of the time seldom reflected a full awareness of Soule's recommendations and Billings's material contributions. The new libraries of Washington, Philadelphia, Indianapolis, and Detroit all revealed functional inadequacies. The architects were striving after the traditional and overblown monumentalism that characterized building during the orgiastic end of historical eclecticism in the 1920's. The Detroit Public Library (1921) is a case in point, although it is one of the best: designed by the talented Cass Gilbert, architect of the Woolworth Tower, the finely proportioned classical facade hides and denies the steel frame, while the formal disposition of functional elements produced an extremely awkward interior plan. No one can guess how long this approach to design might have continued if the depression of the thirties had not stopped most public and private building.

Meanwhile, other innovations in structure and planning were to play a role in the synthesis of form and function that ultimately emerged. One of the many achievements of the prolific Chicago school was a realistic and organic mode of warehouse design in which the building was treated as loft space with an exterior form derived from the articulated frame of timber, steel, or concrete. The little Grommes and Ullrich Warehouse (1901) of Richard E. Schmidt led the architectural critic Russell Sturgis to advocate a similar design for the library building to provide for functional simplicity and flexibility and the maximum admission of light. Schmidt's firm never had an opportunity to design a library, but he and his partners produced a series of triumphs in their hospitals (among them the great Michael Reese Hospital on Chicago's South Side). At the same time the Chicago architects, Schmidt among them, were using reinforced concrete framing on a large scale, both in the older column-and-girder system and the recently developed column-and-flat-slab system, patented in 1908 by the Minneapolis engineer Claude A. P. Turner. It is a refinement of the

latter technique that is used in the subgrade portion of the new Medical Library.

The most advanced structural technique, as we have noted, is the prestressed shell. Shell construction and the prestressing of both shells and framing units are almost exclusively French and German inventions, and their practical development lies wholly in the twentieth century. These techniques were not introduced into the United States until the mid-thirties. At the time when their great economic advantages were most likely to appeal to the builder, another World War prevented the renewal of large-scale commercial and public building. As a consequence, the revolutionary shell and prestressed forms began to appear in quantity only with the mid-century decade. By that time they were finding use in every kind of building, especially those such as schools where economic restrictions were most severe, with the result that the relatively small school or community library increasingly came to reveal the new structural means.

Library design embodying all the features of the modern synthesis—thorough functional planning, fully developed steel and concrete framing, the organic forms of contemporary style—is largely a post-World War II phenomenon. By this time the architects no longer had to rely simply on their own experience and what understanding they had gained from the errors of the past. The publication in 1941 of Wheeler and Githens' *American Public Library Building* provided them with a comprehensive and detailed guide which freed them at last from the limitations of the traditional approach. Regarded by librarians as a landmark in the theory of library architecture, based on seven years of research and on discussions with more than three hundred librarians and architects, Wheeler's book remains an essential document, which we can now see as the product of nearly a century's development in the building arts. The authors' systematic and highly empirical attack on the problems of library planning set the standard that all architects would henceforth have to follow.

The enormous volume of public and private building that began at the mid-century meant that examples of the new design approach came all at once, so that there is no recognizable line of development. In the structural system of pure welded steel framing, Mies van der Rohe's project for the library of Illinois Institute of Technology in Chicago (1940) was something of a pioneer work. Unfortunately this striking design was never realized; the new combined I. I. T.-John Crerar Library, now under construction (1961–62), is the work of Skidmore, Owings and Merrill, but they have followed for the most part Mies's principle of generalized form. The new Medical Library may be regarded as an expression of the same principle in which the exterior envelope is limestone rather than glass. Concrete construction in precast block and vertical slabs appeared in Frank Lloyd Wright's campus plan for Florida Southern College at Lake-

land, the library of which was planned in 1941 and opened in 1947. A particularly good example of functional interior planning for university libraries is the Firestone Library at Princeton (completed in 1947), designed by the architects of the new Medical Library, O'Connor and Kilham. This building is noteworthy for its generous allotment of study space in the form not only of the usual carrels but also of small reading rooms where standard works in the various disciplines are shelved for convenient access to the student. One of the most impressive libraries for its size and straightforward functional character is the big Midwest Inter-Library Center in Chicago (1949–51), designed by Shaw, Metz, and Dolio. This building is a relentless example of emphasis on utility, the primary determinants in the design having been storage and future expansion to an ultimate limit of 10,000,000 volumes.

The new National Library of Medicine includes all the primary structural techniques and very likely the maximum diversity of functional parts. This and other recent libraries make us realize that the day of lavish ornament is gone, so that the library is now more sober than many commercial buildings. The empirical problems have for the most part been expertly solved, and the design of a library is thus as much a science as librarianship itself. Perhaps our major task today is to create buildings with the expressive and symbolic power that once lived in the classical and medieval forms which we have now discarded.

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