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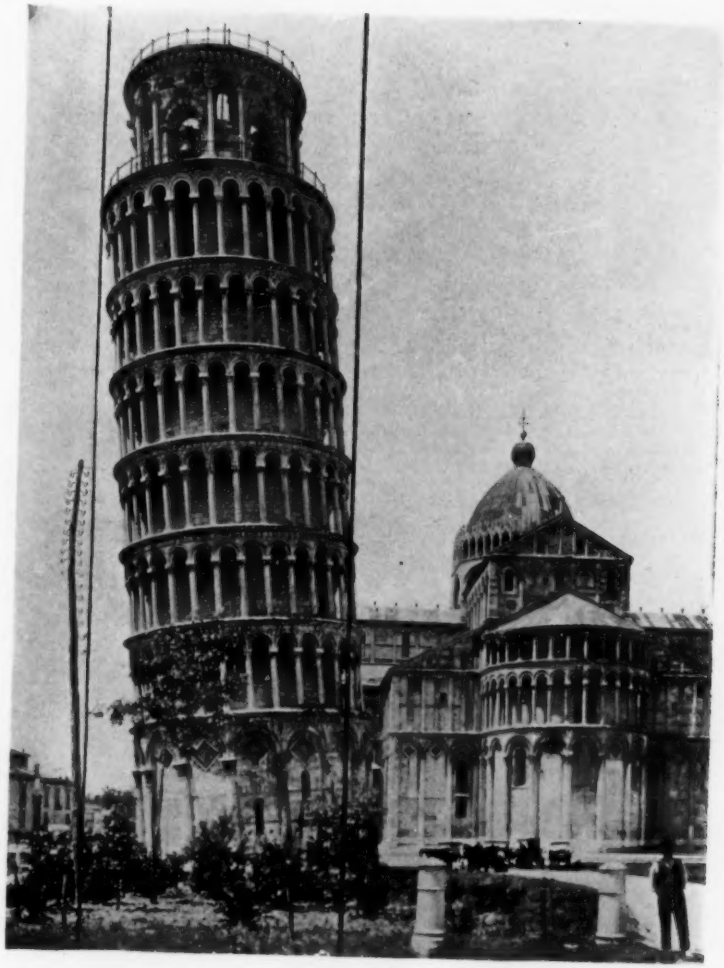
THIS ISSUE CONTAINS

THE SECOND AND CONCLUDING ARTICLE BY PROFESSOR WILLIAM H. GOODYEAR, ON THE LEANING TOWER OF PISA — SOME RECENTLY COMPLETED WORK BY MESSRS. RUTAN & RUSSELL, ARCHITECTS—PREMIATED DESIGNS, SOCIETY OF BEAUX-ARTS ARCHITECTS

VOLUME XCVIII NOVEMBER 23, 1910 NUMBER 1822

THE ONLY PICTURE EVER TAKEN WHICH GIVES A COMPLETE VIEW OF THE WELL IN WHICH THE TOWER STANDS. TAKEN FROM UPPER GALLERY OF THE CATHEDRAL CHOIR.



SHOWING THE BEND TOWARDS THE PERPENDICULAR. FROM BROOKLYN MUSEUM SURVEY. PHOTOGRAPH OF MAY, 1910. ONLY VIEW EVER TAKEN WITH PLUMB LINES. THE PLUMB LINES ARE INSIDE THE CAMERA.

THE LEANING TOWER, PISA

THE AMERICAN ARCHITECT

Vol. XCVIII WEDNESDAY, NOVEMBER 23, 1910 No. 1822

BROOKLYN MUSEUM MEASUREMENTS OF 1910 IN THE SPIRAL STAIRWAY OF THE LEANING TOWER OF PISA

BY WM. H. GOODYEAR, M.A.

Curator of the Department of Fine Arts, Museum of the Brooklyn Institute; Hon. Member Society of Architects of Rome; Hon. Member Edinburgh Architectural Association; Hon. Member Royal Academy of Fine Arts of Milan; Hon. Academician Royal Academy of Venice; Corresponding Member American Institute of Architects.

IT is believed that the long-debated question as to the intentional construction, or accidental inclination, of the Leaning Tower of Pisa may be considered as positively determined in favor of the former theory by a series of 434 measurements, which were taken during the month of May, 1910, in the interior of its spiral stairway.

These measures for the height of the stairway ceiling were taken with a sliding surveyor's rod and read from a vernier. In taking the measures the rod was held close to the wall, at right angles to the slope of the step and of the masonry courses above the step, at the center of the outer side, and at the center of the inner side of each step. As the centers of the sides of the steps, where the rod was placed, were fixed by the eye, some allowance must be made for surveyor's error in this particular. An allowance for this and all other errors, including those of the builders, may be estimated from the third diagram.

If we compare, on Fig. 4, the measures between the point G and the point I, we find the measure at G, for mean height of the ceiling, to be 7.195 feet, and at I to be 7.225 feet. The difference is only 0.03 foot, or ⅜ of an inch, in measures which are removed from one another by 37 steps. In the entire number of 37 steps the highest mean measure is 7.335 feet (192d step) and the lowest is 7.16 feet (194th step). The difference is 0.175 foot, or 2⅛ inches. Two and one-eighth inches is, therefore, an extreme allowance for error of results, as to mean height of the ceiling from whatever possible cause, in these 37 steps.

As regards the dip of the ceiling between the same points, the difference is only 0.04 foot, or ½ inch (0.09—0.05). The maximum variation for dip in the 37 steps is 0.32 foot, or 3¾ inches (dip inward, 0.20 foot at the 180th step, dip outward, 0.12 foot at the 155th step).

The extreme allowance for error of results in measures relating to dip in the given 37 steps is therefore 3¾ inches.

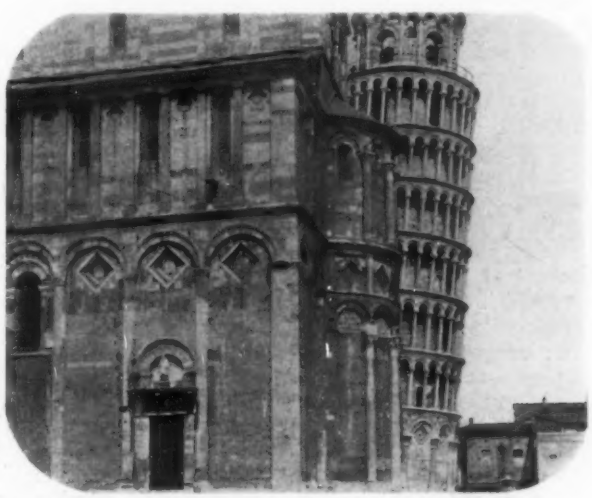


FIG. 1.—The Pisa Leaning Tower from a point of view showing the bend toward the perpendicular.

PROOFS OF AN INTENTIONAL LEANING CONSTRUCTION

We are now prepared to offer the proof that the Leaning Power of Pisa was built to lean. In Fig. 2 we shall find the variation in mean height, on the line of greatest inclination, between the 13th step, F, and the 49th step, H, to be 1.53 feet, or 1 foot 6 inches.

The increase in the dip of the ceiling between the same points is 0.70 foot, or 8½ inches (0.73 — 0.03).

These comparisons are still more remarkable when made from the 34th step at I, which is three steps beyond the quarter-turn on the east side.

In 16 steps, 34th to 49th inclusive, the mean height of the ceiling rises 1.89 feet (9.075 — 7.185), or 1 foot 10¾ inches. The height of the inner wall rises 1.82 feet (8.71 — 6.89), or 1 foot 10 inches. The height of the outer wall rises 1.96 feet (9.44 — 7.48), or 1 foot 11½ inches.

Of still greater interest than the total variations is the unbroken sequence of increment as regards the adjacent measures. The mean rise is obtained by the following mean increments, beginning at the 35th step as compared with the 34th: 0.11, 0.105, 0.095, 0.055, 0.11, 0.12, 0.21, 0.135, 0.08, 0.11, 0.11, 0.205, 0.11, 0.235, 0.10 foot. These rates of increment offer an indisputable proof that an average rate of increase in mean height of not less than 0.10 foot, or 0.11 foot, was definitely planned and carried out. Thus a total error in the height of the ceiling between the range of the 159th and 195th steps, where no system of change was at stake, might amount to 2⅛ inches (including surveyor's error), but in the first story a change between two adjacent measures of 0.10 foot was significant and part of a general plan and system. Not only that, even a change of 0.055 foot is significant of in-

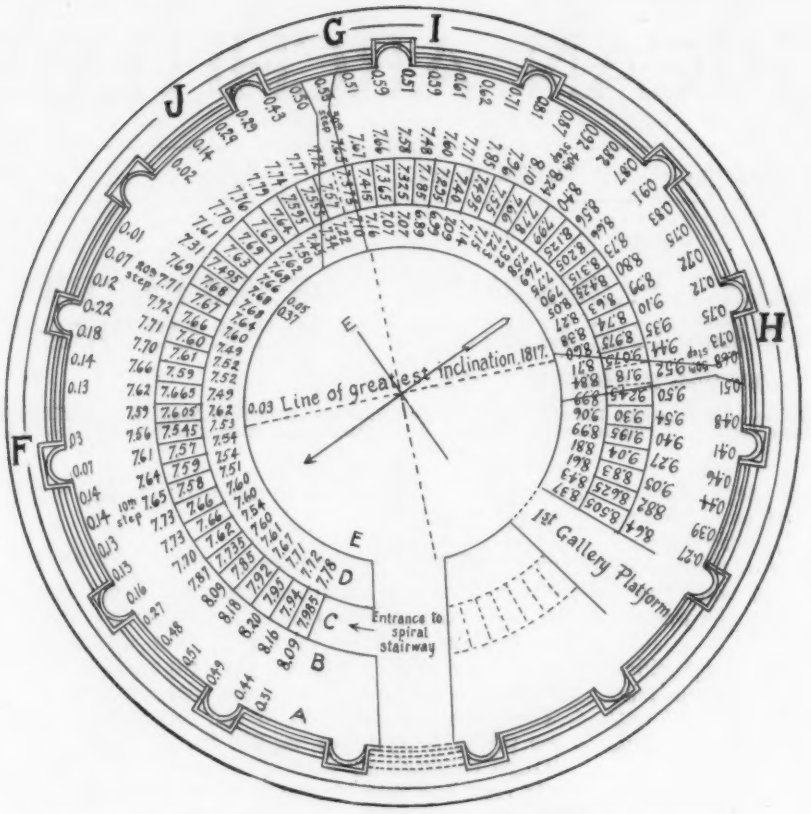


FIG. 2.—Brooklyn Museum measurements of 1910; for the heights of the spiral stairway between the ground floor and the first gallery platform. Measures in feet and decimals. A, B is the outer wall of the tower. The measures of Circle A represent the extra height of the outer wall of the spiral stairway as measured at the outside center of each step and as compared with the inner wall. These measures consequently also represent the amount of downward dip of the stairway ceiling toward the inner wall. The measures of Circle B represent the height of the spiral stairway on the outer side as taken at the outer center of each step. Circle C is the spiral stairway. The measures in this circle represent the average, or mean height, of the stairway at the middle center of each step. These measures are obtained by halving the sum of the outer and inner measures. Circle D is the inner wall of the tower. The measures in this circle represent the inner height of the stairway at the inner center of each step. In Circle E, beyond the line bounding the inner well of the tower, are the measures which represent the extra height of the inner wall of the stairway at the points where it is higher than the outer wall. They therefore also represent the relative dip downward and outward of the ceiling of the stairway when the heights of the inner and outer walls are compared at the given step.

tention. The small increment of 0.055 foot at the 38th step, whether its small amount be due to the builder's error or to the surveyor's error, does not at all indicate an absence of the system which is being demonstrated. On the contrary, it is part of the proof of the existence of a system, and is an illustration of the general delicacy of the ratio of increase between adjacent steps, which produced the total increment in the mean height of the ceiling of 1.89 feet in 16 steps.

The bearing of these measures on the question of purposed inclination is, of course, quite evident. If the ceiling is approximately 2 feet higher on the overhanging side, the weight of masonry on the overhanging side is diminished to that extent and the relative weight in the parts of the tower which do not overhang, as regards the exterior, is increased to that extent as regards the effect on the center of gravity.

It is evident that up to the east quarter-turn at G a relatively low ceiling would add to the stability of the tower by increasing the weight of masonry on the side opposed to the exterior overhang.

The exterior width of a step is about 1.60 feet; the width of the stairway is about 3.61 feet. Thus an increase of 2 feet in height on the overhanging side would represent a decrease of weight on the overhanging side of 11½ cubic feet of masonry above one step. An inspection of the individual measures will render similar computations possible for the steps preceding and following the 49th, as far as the quarter-turns on both sides.

But there is an additional proof of a purposed leaning construction, to be derived from an analysis of the measures for the inward dip of the ceiling.

At the 13th step (F, Fig. 2) there is practically no dip and the inclination of the ceiling is normal to the step inclination. The measures show only 0.03 foot inward dip at the 13th step and only 0.03 foot outward dip at the 14th step. But at the 49th step the inward dip is 0.73 foot, or 9 inches. The inclination of the 49th step is about 0.34 foot or 4 inches. Thus the ceiling is tilted inward at this point 5 inches below the true horizontal line in a width of about 3½ feet.

This is obviously a constructive device to throw the weight of the solid wall above the ceiling toward the inner wall of the stairway and away from the exterior overhang.

During the construction of the first story the dip was evidently considered a device of greater importance, or at least of more far-reaching effect, as regards the general stability of the tower, than the increase in the height of the stairway. The proof of this is that the sequence of increment in the inward dip on the east side begins considerably farther back than the beginning of the steady rise in the height of the ceiling. The uninterrupted increase of the dip begins at the 25th step, J, whereas the steady increase in the height of the ceiling begins at the 34th step, I. Thus the increase from 0.02-foot dip, at the 24th step, has already reached 0.55 foot at the quarter-turn G (in the space of 6 steps), and it is 0.73 foot at the 49th step, H, with even higher occasional variations before that point. In fact, the maximum inward dip is very nearly 1 foot (0.95 foot at the 43d step).

When we consider that the stairway is only about 3½ feet wide (3.61 feet in the first story), it must be conceded that this inward dip of the ceiling is a very remarkable feature of the tower and a very conclusive proof of careful attention to the stability of a purposely leaning construction.

THE THEORY OF ACCIDENT EXAMINED

It will be remembered, from the account of DeFleury's surveys given in the article of September 28, and from the table of measures at the close of that article, that the advocate of the theory of accidental inclination, who understands his own case, is now obliged to hold with DeFleury, that an unequal settlement of the tower

took place at the time when the first story was nearing completion, and before the second story was begun, because the second story bends toward the perpendicular by an increment of 3 cm. in the height of the first gallery on the overhanging side, as compared with the opposite side. Similar successive unequal settlements are held to have occurred at each successive story, and to have been rectified as they occurred, to the total amount of m. 0.86, by the use of similar successive increments. The rest of the unequal settlement is supposed to have happened shortly after the tower was finished, to the amount of m. 0.70.

Mothes, who follows DeFleury closely in this matter, gives a similar detailed account of these imaginary settlements. This theory has no historic or other record to support it, and is only based on the measures which show that the tower bends toward the perpendicular at each successive story.

THE THEORY OF ACCIDENTAL INCLINATION TESTED BY THE SPIRAL STAIRWAY CONSTRUCTION

If this theory has any value whatever it must now be applied to the measurements in the spiral stairway below the first gallery platform. If the changes of height and of dip in the stairway ceiling were not intended to increase the stability of an intentionally leaning tower, they must have been intended to combat the effects of unequal settlement in a given direction and that given direction must have been the line of greatest inclination in Fig. 2. But the advocate of accident, who is obliged to hold that an unequal settlement of 3 cm., only, had occurred when the first story was finished, is now obliged to hold that a settlement in the same direction, and probably of less amount than 3 cm., had been observed when the 13th step, F, had been reached, and also that the builders *knew that any further unequal settlement would continue in the same direction.*

The theory of accident is involved in even greater absurdity than that, for it will next be shown that the system, so far explained from the 13th step upward as far as the 49th step, has its inception *at the first step of the construction.*

The difference between the mean heights of the 1st and 13th steps is 0.44 foot, or 5½ inches (7.985—7.545). This decrease of mean height is largely due to a decrease in height on the outer side, *i.e.*, to the decrease of the inward dip *which begins at the first steps,* and this fact is so significant that we quote here all the measures for the dip, between the 1st and 13th steps, inclusive. They run as follows: 0.31, 0.44, 0.49, 0.51, 0.48, 0.27, 0.16, 0.13, 0.13, 0.14, 0.14, 0.07, 0.03 foot.

There is, therefore, no doubt that the system of dip which rules beyond the 25th step, J, was experimentally begun at the 1st step, that the inward dip was also intended here as an expedient to forestall and correct any tendency to outward movement in the outer wall of the stairway, and that this inward dip was logically abandoned, or much decreased, near the upper side of the line of greatest inclination toward the south, where the inward inclination of the ceiling corresponds to the inward inclination of the step, when the height of the wall is the same on both sides of the stairway. Near this point, any great addition to the southward dip of the ceiling, already inherent in the leaning construction, was naturally held to be an undesirable expedient.

Thus since the spiral stairway has been measured, it is now necessary to hold, according to the present theory of accident, that the precautions which were intended to combat the *unequal* settlement of the building in a certain given direction *were initiated at the time when the building was begun* and immediately after the foundations had been laid. This must be believed in spite of the fact that the same theory is obliged to hold that the inequality of settlement was only 3 cm. when the first story was finished. There may be people whose credulity will go thus far, but mine does not.

We have to consider here that the tower now stands in a well and that the upper north side of the tower is about 4 feet below the adjacent level, whereas the south side is about 9 feet below the adjacent level. In other words, the theory of accidental inclination has to assume a very remarkable direct settlement, besides the unequal settlement which caused the inclination. (See frontispiece.)

DeFleury estimates the minimum direct settlement at nearly 8 feet (m. 2.40), *i.e.*, 8 feet on the upper side, believing that the depression of the immediately surrounding area, as compared with the level of the adjacent cathedral choir, was part of this settlement. Here, then, is a building which is supposed to have gone down 8 feet on the upper side and 13 feet on the lower side, and we are asked to believe that this settlement had begun immediately after the foundations were laid, and we are also asked to believe, although the inequality of settlement *was only 3cm.* at the cornice of the first story, *that the builders knew which way the ultimate and final inequality of settlement would lean the tower before the 13th step was reached.*

Certainly the sceptics as to intentional inclination are now obliged to swallow a very large camel and to strain at a comparatively small gnat.

THE DIP IN THE SPIRAL STAIRWAY OF THE SECOND STORY

Fig. 2 shows measures for eight steps beyond the point of greatest overhang at H, up to the platform of the first story, and Fig. 3 shows the steps farther round the turn.

The rapid disappearance of the dip is to be first noticed. It is abandoned entirely at the 62nd step, which is three steps lower than the quarter turn at Fig. 3, F, west side. Just above that point the dip veers very slightly in the opposite direction and then continues, generally in the inward direction, but in slight amounts, around to the third gallery platform at Fig. 3, I, which is the point of greatest overhang next above, Fig. 2, G. There are 57 steps between the 62nd step near F and the third gallery, inclusive, and the greatest amount of inward dip in the entire series is 0.30 foot. The average is considerably less and eleven measures show a slight dip in the outward direction. The lack of system in the variations is also apparent.

Now, on the supposition that the experiment of building a leaning tower had so far proved a stable success, and that the anxieties attendant on the beginning of such a construction had disappeared, this abandonment of the systematic variations in the dip could be easily explained, because they must have given the masons a great deal of trouble.

On the supposition that the systematic variations in the dip, beginning at the first step and continuing as far as the 62nd step, were intended to combat an unequal settlement, the abandonment of the system cannot be explained, because the settlement continued above the 62nd step, if it took place at all.

HEIGHT OF THE CEILING

The decrease in the height of the ceiling is very marked beyond the 49th step in Fig. 2, up to the quarter turn at F, in Fig. 3. As regards the mean height, the

FIG. 3.—Brooklyn Museum measurements of 1910; for the heights of the spiral stairway between the platforms of the first and third galleries, inclusive. Measures in feet and decimals. Circle A is the exterior gallery. The measures in this circle represent the extra height of the outer wall of the spiral stairway as measured at the outside center of each step and as compared with the inner wall. These measures consequently also represent the amount of downward dip of the stairway ceiling toward the inner wall. Circle B is the outer wall of the tower. In this circle are placed the measures for the height of the spiral stairway on the outer side as taken at the outer center of each step. Circle C is the spiral stairway. The measures in this circle represent the average, or mean height, of the stairway at the middle center of each step. These measures are obtained by halving the sum of the outer and inner measures. Circle D is the inner wall of the tower. The measures in this circle represent the inner height of the stairway at the inner center of each step. In Circle E, beyond the line bounding the inner well of the tower, are the measures which represent the extra height of the inner wall of the stairway at the points where it is higher than the outer wall. They also represent, therefore, the relative dip downward and outward of the ceiling of the stairway when the heights of the inner and outer walls are compared at the given step. Measurements are omitted at the platforms, because the ceilings are flat, and they are also omitted at the steps adjacent to the platforms when the flat ceiling reaches over them.

decrease from the 49th step to the 66th step at F is 1.62 foot, or 1 foot 7½ inches (9.075 — 7.455). *The decrease in the outer measures is 2 feet* (9.44 — 7.44). The decrease in the inner measures is 1.24 foot, or 1 foot 3 inches (8.71 — 7.47).

Of still greater interest is the unbroken sequence in the decreasing numbers. Beyond the 52nd step there is not a single break in the decreasing sequence of the measures for the outer or inner side or for the mean amount. This continuity of downward variation is an unimpeachable proof of the continuance and purpose of the system which begins at the first step of the stairway.

Thus in the 16 steps, from the 34th to the 49th, the mean height of the ceiling increases 1.89 foot, or 1 foot 11 inches, and it decreases from the 49th step to the 66th. 1 foot 7½ inches in 17 steps.

We remember that the continuous increase of the dip, up to the 49th step, began farther back, at the 25th step, with total increase 0.70 to the 49th. Its decrease is of the same amount, but is completed before the quarter turn at F, Fig. 3, is reached.

HEIGHT OF CEILING TO THIRD GALLERY PLATFORM

The variation in mean height in the next quarter turn, from F to G, the point opposed to the overhang, in Fig. 3, need not detain us. The variation is only 0.365 foot (7.82 — 7.455), or 4¼ inches.

The mean rise of the ceiling in the next half spiral turn from Fig. 3, G, 86th step, to Fig. 3, I (118th step), on the side of the overhang, is 8.345 — 7.82 = 0.525, or 6 inches. This rise is doubtless a feature of the original prearranged plan, as found on the corresponding overhanging side lower down. The entire system of variation in the height of the stairway, as so far developed, was, however, abandoned at the third gallery platform and the diminution of the amount of rise in the last half spiral turn, as compared with the larger measures lower down, is certainly significant of the approaching abandonment of the system.

CHANGE OF BUILDERS AT THE FOURTH STORY, SEE FIG. 3

The accounts of Mothes,* who is the best authority in such matters, make it possible that Bonanno, the first architect of the tower, was absent in Monreale, near Palermo, during the construction of the next story (third gallery). At all events it is certain that the construction came to a halt in 1186 until 1233, after the fourth story (third gallery) was finished. The period of inactivity had then lasted about 50 years.

Beyond the third gallery platform (Fig. 4, E, D, C, B, A) the mean height of the stairway rises very abruptly from 8 feet at the 120th step, next the platform E, D, C, B, A, to 9.625 feet at the 133rd step. The mean height then decreases to 8.50 feet at the 148th step, next the fourth gallery platform.

We may assume that the increase in the height of the stairway on the west side was originally intended to be continuous throughout the remainder of the construction and that it was intended to diminish the weight of the wall in the upper stories. Several other effective expedients were undoubtedly employed to that end, especially the successive reductions in the thickness of the tubular wall, to be presently mentioned. These reductions in the thickness of the wall probably made the continuance of the high stairway inadvisable, as the main upper weight of the tower had to be supported by these narrow walls which enclose it. The thickness is only about 2 feet 3 inches in this story.

Whether the expedient was abandoned by its original devisers or by builders who followed them at a later date, of course, cannot be determined. The temporary revival of the dip system in connection with the rise of the ceiling in the quarter turn on the overhanging side, from the 120th to the 132nd step, between I and F, Fig. 4, speaks for itself in the measures. This was certainly suggested by considerations relating to the danger of an outward movement of the high wall of the stairway and in view of its diminished thickness.

It is also extremely significant that, when the fourth gallery platform was reached, the stairway was lowered an entire foot as between the steps on either side of the platform (8.50 feet, 148th step, lower side; 7.41 feet, 150th step, upper side). Such an abrupt change of

*Die Baukunst des Mittelalters in Italien, II, p. 737.

(*Continued on page 174*)

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Editor,
Charles Francis Osborne,
(Department of Architecture, University of Pennsylvania.)
Associate Editor, William H. Crocker.

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CONTENTS

PROFESSIONAL COOPERATION

PRACTISING architects are usually too busy with the work in hand to be willing to devote much time to conscious efforts to "uplift" their profession in the estimation of the public, and are often the more loth to do so through lack of sympathy with the well-meaning efforts of reformers. The situation might be clarified to some extent if an analysis were made of existing conditions, as busy men feel it is not worth while to take part in concerted professional movements until it is quite certain that the thing attempted is worth doing and that the means proposed are suitable.

The situation itself is not complex and may be described as chiefly due to a lack of understanding of the art of architecture on the part of the public, but partly, also, to the fact that the coming generation of architects stands for different ideals from those which content the bulk of the older men. In other words, professional development in the architectural world is in a state of transition due to the introduction of new methods of training. Even the older men will agree that our national architecture has greatly improved within the last decade or two, and would, no doubt, be willing to concede that this improvement has been largely due to the initiative of the new school of design. Here, then, is the clue to a common working agreement between the old and the new. If the older men will work in sympathy with the newer ideals, and in replenishing their office forces will fill up the ranks with men trained in the new way the differences in point of view will be rapidly removed and there will be a united effort and one mind. This accomplished, the public will be no longer disturbed by radically divergent views in the ranks of the profession, and those public meetings at which architects, under the direction of chapters and societies, interest the public in architectural matters, whether purely practical, purely æsthetic, or entirely historical, will gain greatly in efficiency and results.

JOHN LA FARGE

THE death of John La Farge at the ripe age of seventy-six removes from the ranks of American artists one whose personality and accomplishments placed him in the forefront of his profession. The architectural world knew him best as a mural decorator and a worker in glass windows. It was in the latter field, especially, that his vivid color sense and his remarkably skillful technique produced a revolution in American window design. He invented what has come to be known as "American" glass, and fused his metal supports into the glass, and introduced various translucent substances and even precious stones into his composition. His method was so revolutionary that he was subjected for a time to violent critical attacks, but these subsided and the great merit of his work has been for some time fully recognized. Trinity Church, Boston, contains a number of his windows, and there are others pretty widely distributed geographically. Perhaps the most notable, as expressing his peculiar art, are "The Battle Window" in Memorial Hall at Harvard, and the "Peacock Window" in the Worcester Museum. Mr. La Farge enjoyed a wide popularity at home and abroad and had been honored in America with the presidency of the Society of Mural Decorators and of the Society of American Artists and was an Officer of the Legion of Honor. He was distinctly an artist of the highest rank in his chosen field of mural decoration and in his death America loses a strong personality.

"THE BUSINESS" OF AN ARCHITECT

IN a recent address before the Texas State Association of Architects at San Antonio, the vice-president, Mr. Wahrenberger, as reported in the local press, laid especial stress on the fact that the architect of to-day must be a practical business man on account of the increased public demand for skyscrapers and business structures generally. This idea might be expressed more exactly by saying that the architect should be a man of affairs, cognizant of and having a sympathetic understanding of every activity of his environment. As "a business man" he must, of course, be able to conduct his clients' architectural affairs to a satisfactory conclusion; but in one's insistence on the architects' business qualities it should not be forgotten that it is not necessary merely to get buildings built, but it is of the essence of the affair that they shall be worth building—which brings us back to the fundamental conception of the architect as a designer and an artist.

CONVENTION AFFAIRS

THE great activity displayed by the chapters of the Institute at their annual meetings, now taking place throughout the country, is an encouraging indication that the convention at San Francisco will have submitted to its consideration matters not only of importance but of immediate pertinence. We have already called attention to the special attractions offered by the San Francisco chapter to visiting architects and it seems likely that the attendance will be as large and widely distributed as the significance of the occasion warrants. It is especially to be hoped that members from a distance will arrange their affairs accordingly.

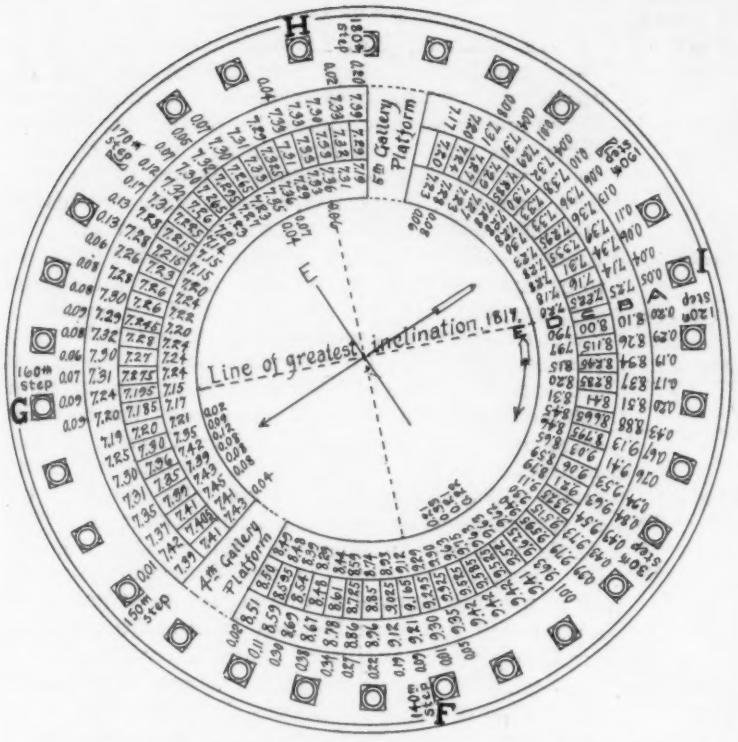


FIG. 4.—Brooklyn Museum measurements of 1910; for the heights of the spiral stairway between the third gallery platform at E, D, C, B, A and the 195th step between the fifth and sixth gallery platforms. The circles A, B, C, D, E correspond to those described in the preceding diagram, Fig. 3. Measures in feet and decimals.

(*Continued from page 172*)

height is otherwise wholly foreign to the system of the stairway. A new architect, Benenato, took charge of the construction above the fourth gallery platform in 1233, and this lowering the height of the stairway by one foot (1.09) was therefore due to him.*

Beyond this point the measures have been already analyzed, and it was from these measures, for the stairway of the fifth and sixth galleries, that we were able to determine the extreme limit of builders' and surveyor's errors for the lower stories of the tower. There is no further significant change in the height of the stairway, and this applies also to the 22 steps beyond the limit of Fig. 4.

EXTERIOR RECTIFICATION OF THE OVERHANG

Exactly at the point where the system followed in the three lower stories of the stairway was finally abandoned, the exterior rectifications increase. The interior system of alternate rise and fall in the height of the stairway, and the relations of this rise and fall to the overhang, is abandoned at the third gallery platform (Fig. 3, I; Fig. 4, E, D, C, B, A). The exterior rectifications so far had been 3 cm. in the first gallery and 4 cm. in the second gallery, but they increase to 7 cm. in the third gallery, 15 cm. in the fourth gallery, 8 cm. in the fifth gallery, 11 cm. in the sixth gallery, and 38 cm. between the cornice of the sixth gallery (or seventh story) and the platform of the eighth story.

The question may, therefore, be fairly asked: If these rectifications represent efforts to correct a series of settlements of corresponding amount, why were the corresponding efforts to weight the tower more heavily in the spiral stairway on the side opposed to the overhang, and to reduce its weight on the overhanging side, abandoned above the third gallery platform?

The only possible answer is that neither device was intended to correct a settlement. Both devices were intended to contribute to the stability of an intentionally inclined tower and when that stability was found to be assured, the troublesome variations in the height of the stairway were abandoned and the system of exterior rectification was the only one which was continued.

THE EIGHTH STORY

If the measures of DeFleury for the height of the eighth story, *above the platform*, be examined, it will be found that its upper north side is 16 cm. higher than the south side.* Cresy and Taylor even made the north side 11 inches higher than the south side (Figs. 3 and 4, article of September 28).† Thus, as DeFleury's original section shows, the platform of the eighth story even has an extra step on the south side and is raised on the south side 38 cm. more than on the north side, whereas the top of the same story tilts down an extra 16 cm. in the overhanging direction.

On the theory of intentional construction this is an interesting point. Having rectified the inclination of the tower to the total amount of m. 0.30, or 1 foot (see article of September 28), the builders gave a rake to the top of the eighth story which tends to conceal the final rectification and adds to the effect, but not to the danger, of the lean.

The explanation of Mothes in the passage already mentioned is rather a labored one. He holds that when the eighth story platform was built the architect found a settlement, following the others which had previously been rectified, of 22 cm., and that he gave the platform a total extra elevation of 38 cm. on the south side, thus tilting it *down 16 cm. to the north*, in order to counteract the anticipated farther settlement to the south, before it took place. Then, the theory continues, as the anticipated settlement was only 2 cm., the south wall of the bell chamber was made 14 cm. lower‡ in order to bring it to a level. Then, according to this theory, after the tower was completely finished, the additional 70 cm. of settlement took place.

THE THEORY OF ACCIDENT RE-EXAMINED

It is a notable point about the utterances of many partisans of the settlement theory that they have spoken rather contemptuously of the opposed opinion. They ought to have remembered, in the past, that a balance of probabilities was at stake, and that much improbability attached to their own theory.

There was the improbability that a tower which went down 8 feet on one side and 13 feet on the other side should have leaned so far without going over entirely, and that it should afterwards have come to rest, in a solid and robust condition, for so many centuries.

*The fifth gallery (sixth story) was not begun until 1260. This and the sixth gallery (seventh story) were built by Wilhelm von Innsbruck. The bell chamber, by Tomasso da Pisa, was not built until about 1350.

*See the original *Monuments de Pise*, pl. xxiv. These measures are M. 7.41, north side, and M. 7.25, south side.

†These reproduce Grassi's re-engraved plates from Cresy and Taylor and correct serious errors of transcription in the originals. Cresy and Taylor's exterior, pl. 25, makes the north side 44 ft. 6 inches instead of 24 ft. 6 inches. The south side is 23 ft. 7 inches. Cresy and Taylor's interior section, pl. 24, figures both sides at 24 ft. 6 inches. Grassi has undoubtedly made the corrections which show the figures intended on both plates, viz., 24 ft. 6 inches, north side, 23 ft. 7 inches, south side.

‡Mothes makes the south side 7.27 instead of 7.25, as found in De Fleury's section, from which he took his argument.

There was the farther improbability that masons would have risked their lives on a constantly sinking building, or that architects would have gambled on the chances of the ultimate arrest of the settlement, which must have seemed most improbable then, as it is admitted to be most wonderful now, by the advocates of the settlement theory.

Amico Ricci, who is the standard Italian authority on Italian Mediæval architecture,* was a sturdy advocate of the theory of intentional leaning construction in the tower at Pisa, as related to, and suggested by, the leaning towers of Bologna. Besides many conclusive arguments relating to the construction of the leaning towers of Bologna, he advances another which may be applied with even greater force to Pisa. He quotes the laws of the Italian Communes which compelled the owners of dilapidated or accidentally leaning towers to take them down, because they were a danger to the public safety. Ricci appeals to these laws as proving that the towers at Bologna must have been known as intentional constructions. Otherwise, he says, the owners would have been compelled by the laws to take them down.

This argument certainly suggests a grave doubt whether the architects of the Pisa tower would have been allowed, by the Communal authorities, to continue it, under the frightfully dangerous conditions which the settlement theory presupposes, even if the architects had been the foolhardy men which this theory presumes them to have been.

CONCLUSION

The improbabilities which, it must be admitted, always attached to the settlement theory, appear to have reached their climax with the revelations of the present article. If the tower leaned only 3 cm. when the first story was approaching completion, how could the builders have known in what direction the tower was ultimately going to lean before they reached the 13th step?

It may now be remembered how many features of the Pisa Campanile appear to harmonize with the desirable conditions of a carefully thought out plan for the construction of a leaning tower, whose center of gravity should fall within the limits of its foundation and whose safety would thus be thoroughly insured. That the upper stories have galleries of light arcades, resting on a robust and much heavier lower story, is apparent at the first glance. A comparison of Figs. 2 and 3, which reproduce the Cresy and Taylor plans of the ground floor and of the second story, illustrates the comparative thickness of the walls of the lower and upper stories.

Not only do the arcades of the upper stories represent the mission of diminishing the wall mass, without losing the effect of the lower outer diameter, but the same idea is apparent in the construction of the tower in the form of a cylinder, with a central void of over 25 feet diameter above the first story. One could not imagine a more ideal combination of the greatest amount of strength, both real and apparent, with the least amount of masonry weight. The thickness of the wall is also diminished by an increase in the diameter of the interior well amounting to 16 inches.

How the walls diminish in thickness, is shown by the following measures:

1st story (including the engaged columns),	15 ft.	1¼ in.
2d story,	8 ft.	11½ in.
3d story,	8 ft.	6¾ in.
4th story,	8 ft.	2 in.

Storia dell' Architettura in Italia, vol. i, pp. 577-584.

There is also something to be said as regards the well in which the tower stands, which is supposed by the advocates of the accident theory to indicate a downward settlement, of an amount otherwise wholly unheard of in the case of any similar building.* Given the idea of building an arcaded leaning tower, with engaged columns on the lower and more robust story, and it would have been clearly impossible to begin such a building on a level surface. If the engaged columns were to have equal height, the base must slope, and if the base were built to slope that slope should, from an artistic point of view, be placed below the surface level. The well is an indispensable feature in the present beauty of the tower, "the lily leaning in the wind," as Edward Hutton styles it.

THE PRIORITY OF GRASSI'S OBSERVATIONS

Although the bending of the tower toward the perpendicular was supposed by Vasari and by Cresy and Taylor, as it still is supposed by many contributors to the recent literature of the subject, to begin above the fourth story, it was already known to Ranieri Grassi that the bend toward the perpendicular is found in every story above the first. He quotes this fact as significant for a purposed inclination, which was intended to impress the spectator as being greater than it really is, and which, at the same time, was carefully constructed for permanent stability. The downward slope, to the south, of the summit of the bell chamber, when contrasted with the uplift of the platform of the same story on the same side, is also very significant.

Grassi was also the first to mention the inward dip of the ceiling, on the side of the overhang, below the first gallery platform, and he was the first to mention the increase in the height of the stairway between the 13th and the 49th steps.† In these and in many other particulars his observations deserve the highest credit, in spite of the deficiency of measures which he only offers in one not very important instance.‡

Be it noted also that the "line of greatest inclination," as marked on the diagrams, does not follow the line of Cresy and Taylor's ground plan. As regards both the 13th and 49th step it not only corresponds to my own recent observations, but it also corresponds to those of Grassi. I believe the southern point of inclination to have been correctly fixed by Cresy and Taylor, but as regards the northern point I agree with Grassi, who was probably right in the early part of the nineteenth century, if I am right now.§

The Pisa Commission believes that the line of greatest inclination has shifted since Cresy and Taylor's publication. This may be doubted, since their line of greatest inclination strikes the ninth step on the north side opposed to the overhang. It probably ought to strike the thirteenth step.

In a future article I shall be able to show that the Pisa Baptistery, which preceded the tower in point of time, is an intentionally leaning construction. The proofs are conclusive.

*There are many leaning towers, but no other one can be mentioned which has settled downward with even remote approximation to the figures for direct settlement which must be quoted here.

†My own earlier measurements in the spiral stairway, as published in the American Architect of October 27, 1909, were made at 6 steps instead of 217. These new measures naturally supplant the former. The former measures test very satisfactorily beside the present ones, when compared *at the same steps*, but the choice of the step on the line of greatest inclination was assisted during the present observations by a compass and by careful use of a short plumb line. The only error which I have been able to find in the former observations is an over-estimate of the dip at the 16th step. This over-estimate was probably due to unequal placing of the surveyor's rod on opposite sides of the same step.

‡References to all three of Grassi's works will be found in the article of September 28th.

§Grassi fixes the points of greatest inclination as ten steps below the first gallery platforms and twelve steps above the ground floor; *Descrizione di Pisa e Suoi Contorni*, vol. ii, pp. 101, 102 (1837).

CRITICISM BY THE JURY OF THE WORK ON EXHIBITION NOVEMBER 7-12. CLASS "A" I PROJET (Problem in Design) "A COUNTRY INN"

As is customary, the Committee on Education met in advance of the judgment and examined the drawings to see if they fulfilled the requirements established by the regulations for the Season 1910-11, and the Programme of Competition. The committee was forced to place "Hors Concours" sets of drawings for non-observance of regulation No. 5, which states that the standard sizes for mounts are obligatory: Stretcher No. 1 (40″ x 62″) and No. 2 (31″ x 40″), also all sets of drawings which were not mounted, according to the regulations established by the Programme, on Stretchers No. 1 and No. 2; several being mounted on three or more stretchers and on two of number one stretcher, which is a distinct violation of the requirements. This action was later reconsidered as there seemed to be some misunderstanding.

Students are hereby notified officially that all the regulations are to be strictly enforced during this season and special attention is directed to Regulation No. 4, reading as follows: "The limiting dimensions established by the Programme must not be exceeded." This refers to the size of the Esquisse-Esquisse, and the size of the Esquisse, if the size is specially mentioned in the Programme of Competition.

Opportunity is hereby granted to students who failed to fulfill these conditions in the programme for Class "A" II Projet to retrace the original sketch correcting the error in size, submitting it to the Chairman of the Committee on Education. A very small percentage of the sketches received are incorrect.

The appearance of the drawings on exhibition at first glance was most pleasing, but on further consideration it was found that, although the programme calls for three full stories and attic and states that the kitchen, scullery, servants' quarters, etc., will be provided in the basement and attic, several of the drawings failed to provide for the same, as was shown by the section.

In many cases the building was designed as a three-story building instead of a five-story building, which, of course, greatly simplified the problem. Such drawings were placed "Hors Concours," as not fulfilling the requirements of the Programme.

Students are urged to prepare the preliminary sketches with greater care and in such a manner as to meet the requirements.

The presentation of the drawings was uniformly good, and the designs of great merit.

Class "A" Esquisse-Esquisses were well up to the standard, although several exceeded the dimensions of the sheet as established by the programme and some were placed "Hors Concours" accordingly. In this instance, however, this was only done when the drawings themselves exceeded the dimensions established by the programme.

The Committee on Education is pleased to note the increasing interest in the Esquisse-Esquisses, which were uniformly of higher average than formerly, although but few were found to be worthy of mentions by the Jury after careful examination, the problem being a difficult one.

NOTIFICATION OF JUDGMENT OF NOVEMBER 8TH

Conducted by the Committee on Education.
The Jury consisting of 11 members of the Society.

Class "A" I Projet (Problem in Design)

"A COUNTRY INN"

The Committee received 67 Esquisses (Preliminary Sketches) and 36 "Projet Rendus" (sets of Final Drawings). Others being delayed by the Express Drivers' strike in New York will be judged on Nov. 29th.

The following awards were made by the jury:

Name	*Award*	*Atelier*	*City*
C. E. Hall	1st Medal	Hornbostel	New York
Geo. Holland	2d "	"	" "
J. Moscowitz	" "	Bosworth	" "
A. L. Flanagan	" "	Prevot	" "
D. Allison	" "	Carnegie Tech. School	Pittsburg.
Wm. Gehron	M	" " "	Pittsburg.
Le Roy Barton	M	Prevot	New York.
A. M. Kirschbaum	M	"	" "
J. F. Hellmuth	M	Barber	" "
L. Beibigheiser	M	Bosworth	" "
A. H. Gilkinson	M	Carnegie Tech. School	Pittsburg.
C. D. Hasness	M	" " "	"
P. S. Mewhinney	M	" " "	"
W. F. Burkhardt	M	" " "	"
A. Hazell	H C	Ware	New York.
W. P. Coleman	H C	"	" "
H. Tatton	H C	Donn Barber	" "
V. Rigaumont	H C	Hornbostel	" "
C. S. Pierpont	M	Ware	" "
F. Peirir	H C	Hornbostel	" "
A. J. King	M	Barber	" "
J. H. Taylor	M	Washington Arch	Washington, D. C.
A. C. Finlayson	M	" "	" "
P. S. Sterling	M	Carnegie Tech. School	Pittsburg.
L. E. Langille	M	Washington Arch	Washington, D. C.
Thos. Raquere	M	Carnegie Tech. School	Pittsburg.
F. H. Brindle	M	Bosworth	New York.
E. Grzybouski	M	Prevot	" "
E. L. Ellis	M	Ware	" "

Class "A" I Esquisse-Esquisse (Rendered Sketch)

"AN OPEN AIR BAND STAND"

The Committee received 21 Esquisse-Esquisses for exhibition and judgment.

The following awards were made by the Jury:

Name	*Award*	*Atelier*	*City*
Robt. M. Wright	2d Medal	Cleveland Arch	Cleveland.
A. E. Flanagan	M	Prevot	New York.
Steward Wagner	M	Hornbostel	" "
A. M. Kirschbaum	M	Prevot	" "
C. Romer	M	Hornbostel	" "
J. Moscowitz	M	Bosworth	" "

Class "B" I Esquisse-Esquisse (Rendered Sketch)

"A STATE SANATORIUM"

The Committee received 21 Esquisse-Esquisses for exhibition and judgment.

The following awards were made by the Jury:

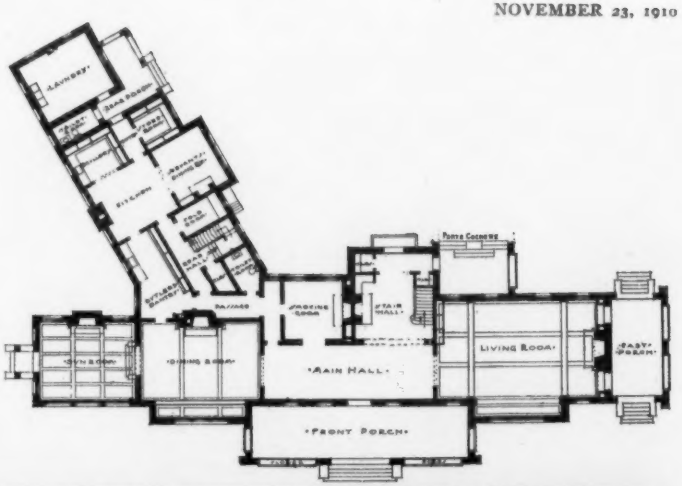
Name	*Award*	*Atelier*	*City*
R. Reginald Rose	1st Mention	Carnegie Tech. School	Pittsburg.
E. W. Boyer	M	" " "	"
John England, Jr.	M	" " "	"

ENTRANCE FRONT AND FIRST FLOOR PLAN

RESIDENCE OF WALLACE H. ROWE, ESQ. COBOURG, ONTARIO, CANADA

RUTAN & RUSSELL, *Architects*

The exterior and interior walls of this house are of brick and tile; the floors of hollow tile and reinforced concrete in long spans. All material employed is as fire-resisting as possible. The finish of exterior walls is of cream white concrete stucco, with a "pebble dash" surface. The interior woodwork is principally painted cream white, with mahogany base boards and window sills.



GARDEN FRONT

EXTERIOR DETAIL

HOUSE OF WALLACE H. ROWE, ESQ., COBOURG, ONTARIO, CANADA

RUTAN & RUSSELL, *Architects*

INTERIOR OF DEN

RESIDENCE OF WALLACE H. ROWE, ESQ., COBOURG, ONTARIO, CANADA

RUTAN & RUSSELL, *Architects*

VIEWS IN HALL

RESIDENCE OF WALLACE H. ROWE, ESQ., COBOURG, ONTARIO, CANADA

RUTAN & RUSSELL, *Architects*

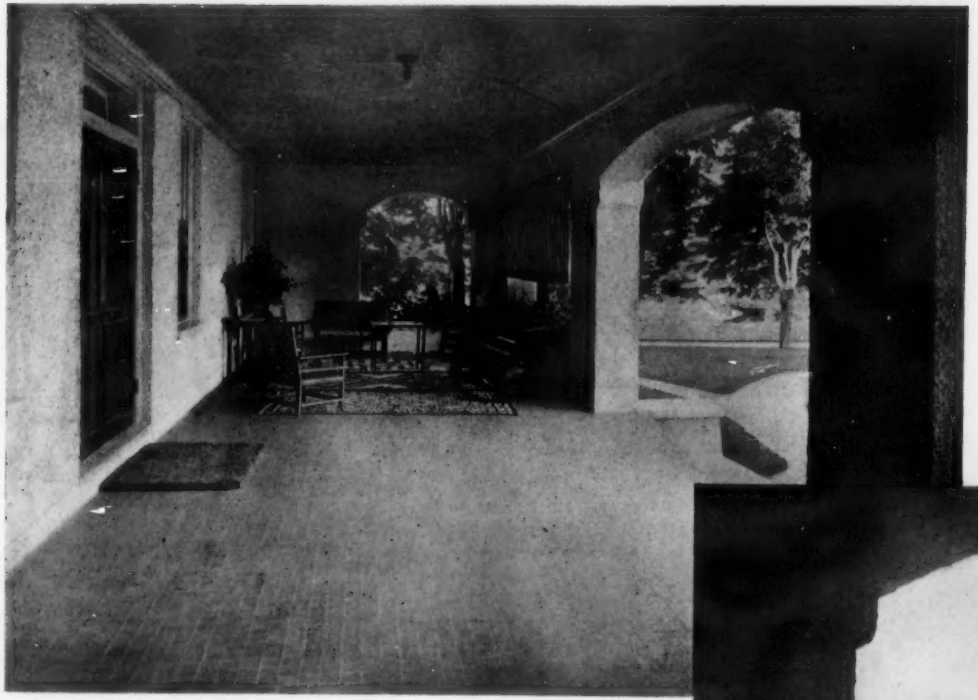
BEDROOM AND DETAIL OF PORCH

RESIDENCE OF WALLACE H. ROWE, ESQ.

COBOURG, ONTARIO, CANADA

RUTAN & RUSSELL

ARCHITECTS



PORCH AND VIEW OF GARDEN

RESIDENCE OF WALLACE H. ROWE, ESQ.,

COBOURG, ONTARIO, CANADA

RUTAN & RUSSELL

ARCHITECTS

THE GARDEN

RESIDENCE OF WALLACE H. ROWE, ESQ.,

COBOURG, ONTARIO, CANADA

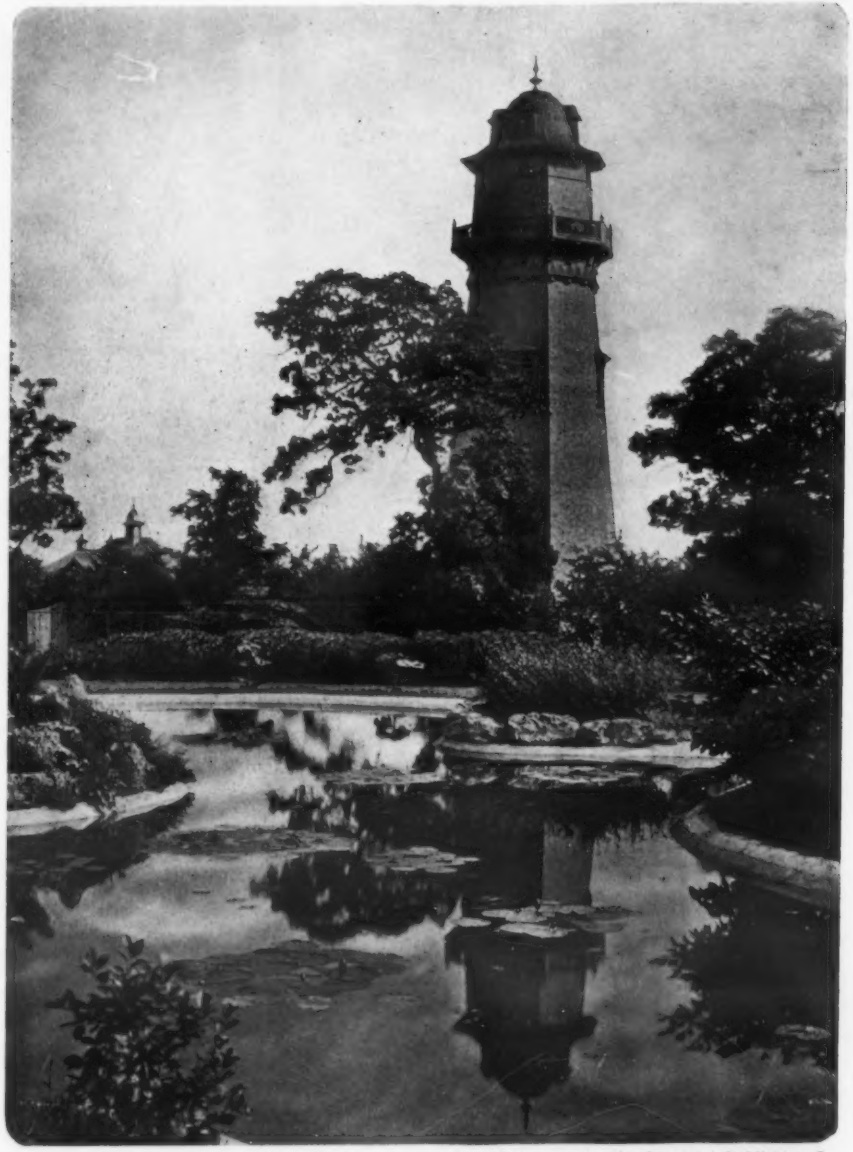
RUTAN & RUSSELL

ARCHITECTS

ENTRANCE GATES

RESIDENCE OF WALLACE H. ROWE, ESQ., COBOURG, ONTARIO, CANADA

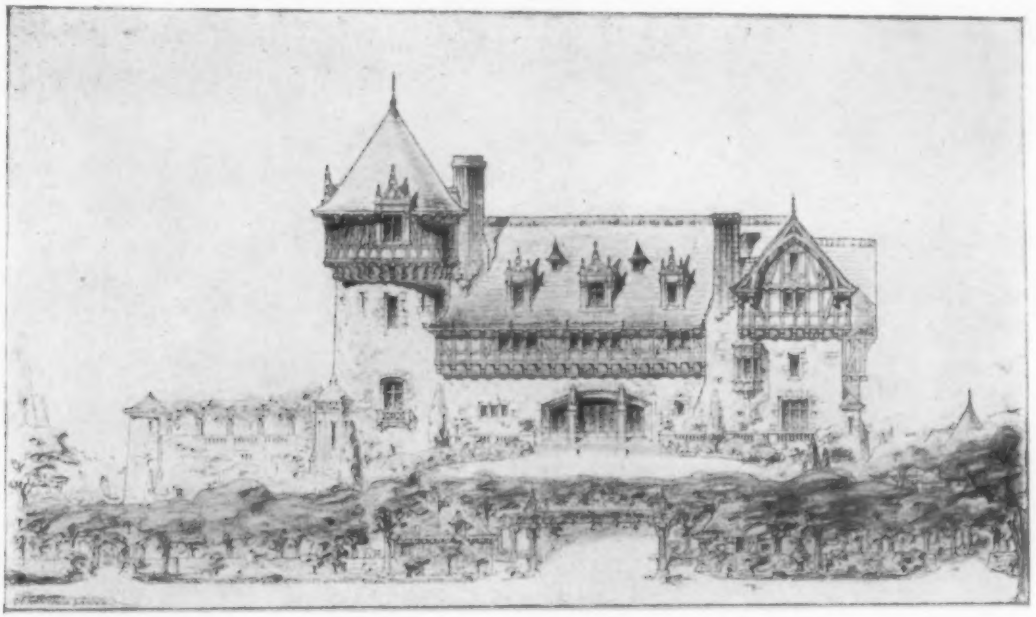
RUTAN & RUSSELL, *Architects*

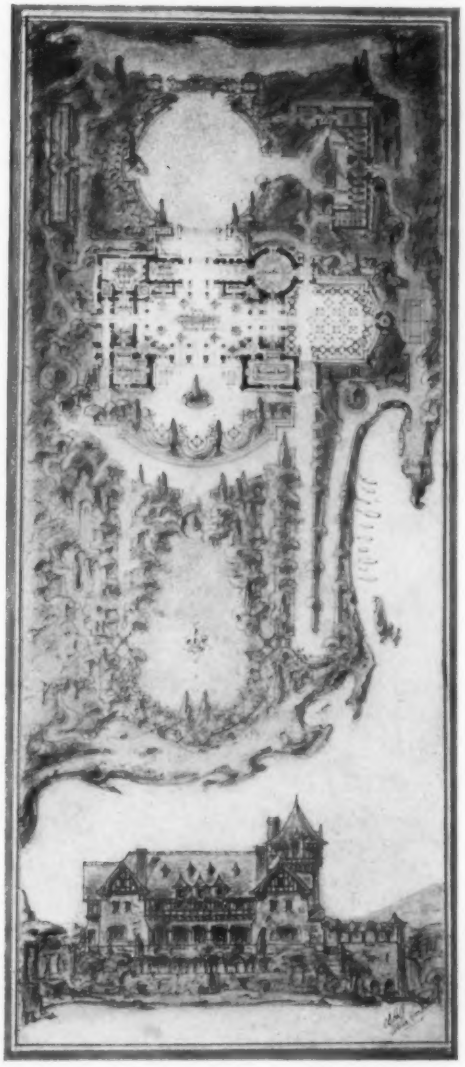


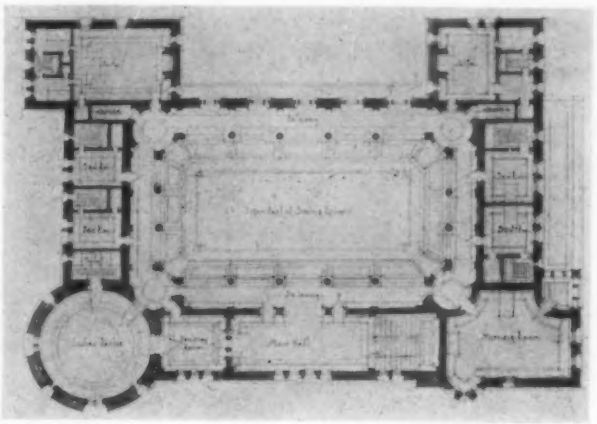
WATER TOWER

RESIDENCE OF MRS. B. F. JONES, SEWICKLEY HEIGHTS, PA.

RUTAN & RUSSELL, *Architects*





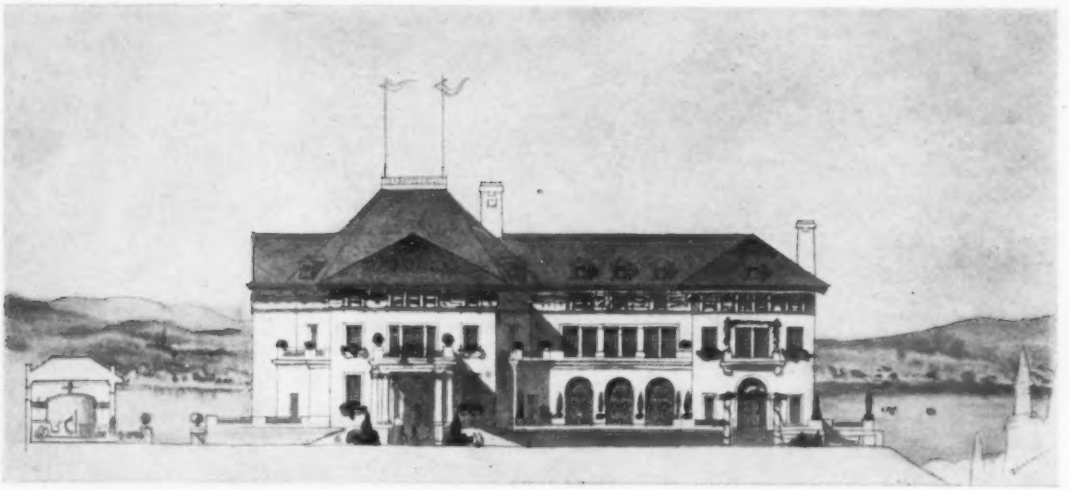


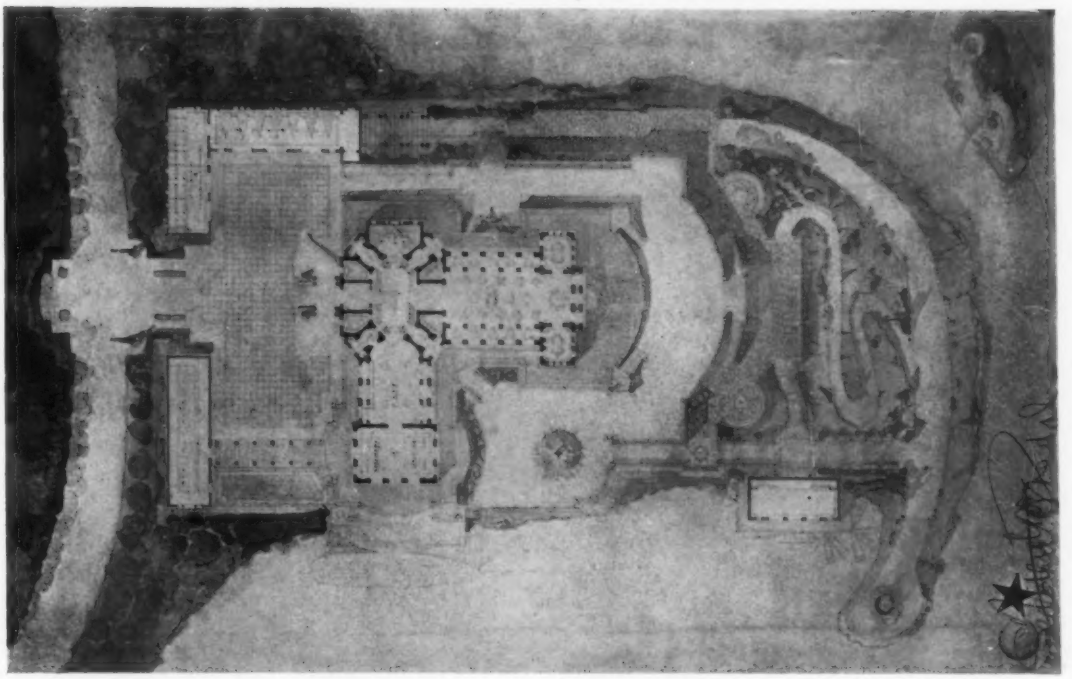
C. E. HALL ATELIER HORNBOSTEL

FIRST MEDAL

CLASS "A" 1 PROJET (PROBLEM IN DESIGN)
A COUNTRY INN

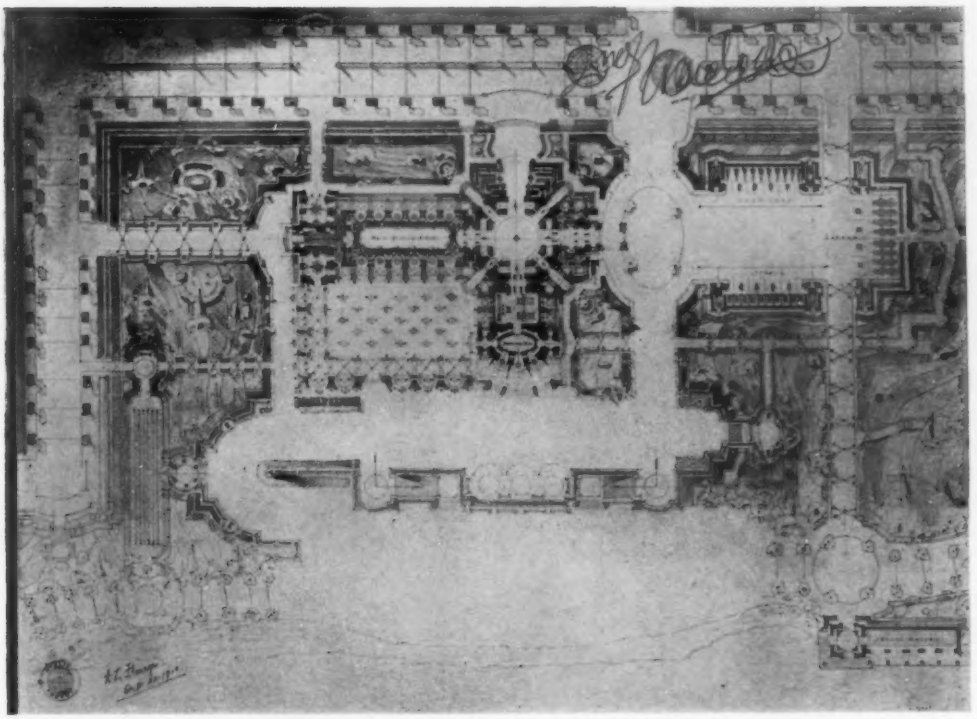
STUDENT WORK, SOCIETY OF
BEAUX-ARTS ARCHITECTS

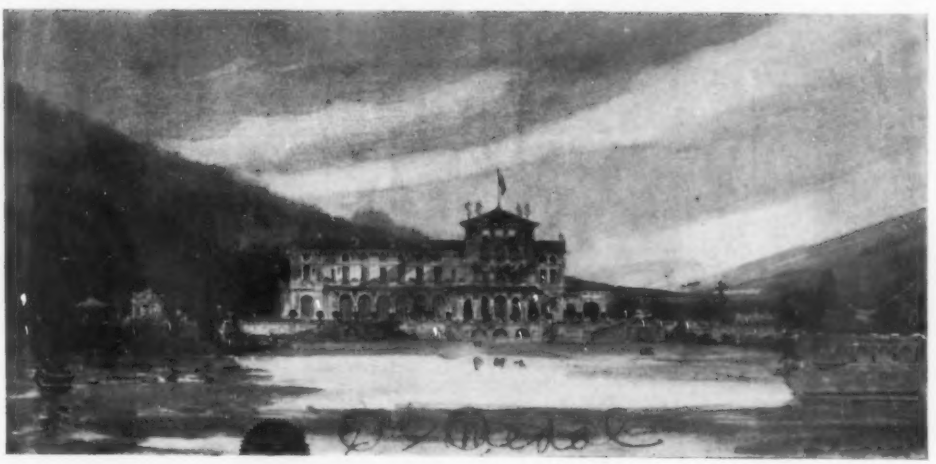




D. ALLISON SECOND MEDAL CARNEGIE TECHNICAL SCHOOLS

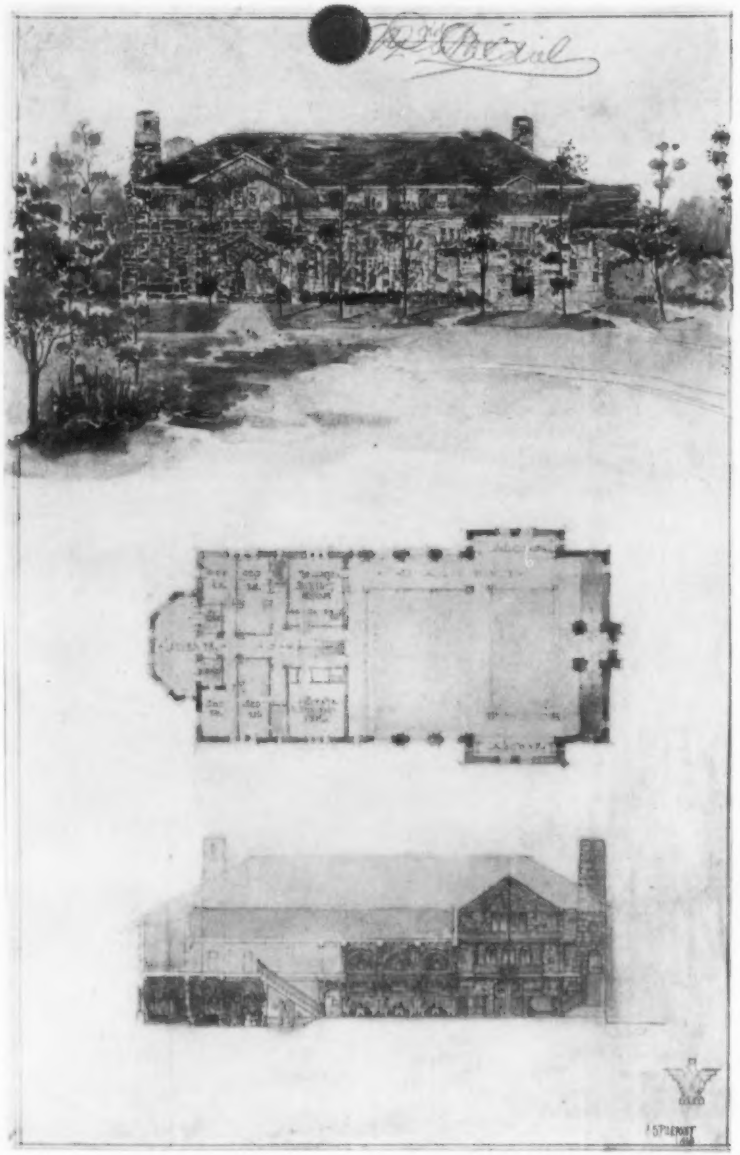
CLASS "A" I PROJET (PROBLEM IN DESIGN) A COUNTRY INN
STUDENT WORK, SOCIETY OF BEAUX-ARTS ARCHITECTS

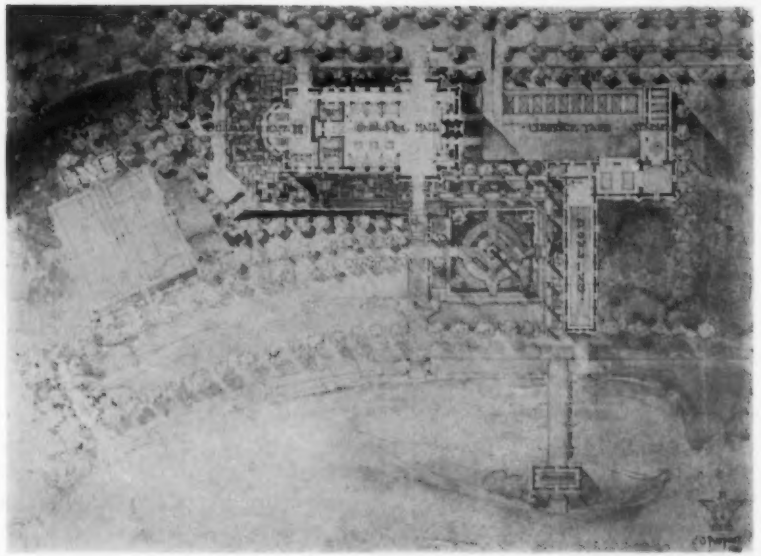




A. L. FLANAGAN SECOND MEDAL ATELIER PREVOT

CLASS "A" I PROJET (PROBLEM IN DESIGN) A COUNTRY INN
STUDENT WORK, SOCIETY OF BEAUX-ARTS ARCHITECTS





C. S. PIERPONT SECOND MEDAL ATELIER WARE

CLASS "A" I PROJET (PROBLEM IN DESIGN) A COUNTRY INN
STUDENT WORK, SOCIETY OF BEAUX-ARTS ARCHITECTS