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THE RELATIVE POSITION OF THE ARCHITECT, ENGINEER AND BUILDER IN MODERN WORKS.

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If we were met together this evening to discuss the relative position of the Architect, Engineer, and Builder, in ancient times, it would to many no doubt be a much more interesting subject than the one that has been chosen, for it would open up an infinitude of matters on which most diverse opinions are held, and afford scope for learned disquisitions from students both old and young. At the same time, however, we should miss many matters that are perhaps of more immediate importance in our practical work. It is, therefore, not proposed in this short paper to touch upon the relative proportions which the technical and æsthetic elements in the Pyramids bear to one another; to enquire how far the Vaults of the Middle Ages are engineering constructions, and how much they are indebted to Architecture for their wonderful qualities and effects; or even to discuss whether Michael Angelo, Brunelleschi, and Christopher Wren were more architects than engineers, or more engineers than architects.

It is coming perhaps somewhat from the broad, sublime, and poetical; to the merely prosaic, and narrow, to descend from such interesting subjects to a consideration of questions connected with the construction of our Sydney buildings in this last decade of the nineteenth century, but it has been repre-

sented to the author that it is desirable for several reasons that there should be an exchange of views between architects, engineers, and builders, on various matters on which they are respectively interested in the carrying out of such works. As one who was among the original founders of this Engineering Association, many years ago, and one who has the interest of both professions at heart, he has consented to lay a few facts before, and submit a few questions to, the representative members and visitors here assembled; hoping that by free discussion an opportunity may be opened out, not only for possible better understanding among ourselves, but for advantages to the community at large.

It surely must be better for all concerned, and much more dignified, that prominent members of the learned professions should discuss matters affecting their interests at meetings such as this, rather than by writing to the daily press, setting forth their differences of opinion, which generally does more harm than good, and affords an opportunity for outside traducers to calumniate professional men generally, by making base charges, such as we have recently witnessed.

There being no hard and fast line of separation between Architecture and Engineering it is no doubt natural that there should occasionally be a slight overlapping of our respective callings. We know, for instance, that many people say they prefer to do without an architect, and to employ a builder who is also an architect; there are persons who act in both capacities it is understood. We also know that some persons prefer to be their own architects, and others directly they become possessed of a piece of machinery imagine they are engineers. And we often see these amateur engineers and architects have to pay pretty dearly for their whistles. Builders to be successful surely have quite enough to do to make themselves masters of the multifarious lines of business that are involved in their work, without attempting to be architects or engineers. And as engineers and architects have

each to devote their whole lives to the mastership of their professions, they have no time to learn to be builders, and as it appears to the writer, would place themselves in a false position if they did.

This is not the place to discuss the singular fact that after an engineer or architect has put his heart and head and his whole life's experience into the perfecting of a design, and has then worried and wrestled with contractors and others to bring it to success, through months, perhaps, of toil and anxiety, besides having to incur a heavy expenditure on assistance, etc., he is paid only the same remuneration (*viz.*, 5 per cent.) that another man can earn in five minutes by getting the order for the work, or for effecting a sale of it when finished, but it does seem a not inappropriate subject for consideration at such a meeting as the present one.

Coming now to the practical relations of the architect, engineer, and builder. Fergusson, in his history of Architecture, defines Architecture as "The art of ornamental and ornamented construction," and Civil Engineering as "the art of disposing the most suitable materials in the most economical and scientific manner to attain a given utilitarian end." Since Fergusson wrote, however, so many great changes have come over the world, and such advances have been made in the practical application of electrical, pneumatic, hydraulic and other sciences, that mechanical engineering (in a manner aforesaid not even dreamt of) now plays a most important part (as well as civil engineering) in the economy and construction of modern buildings. Without going into such matters as the special engineering construction now carried out in some American cities, where the architectural and æsthetic treatment, if whether of granite, freestone, marble, brick or terracotta, is applied as a mere veneer to an erection of iron work, and has apparently the same relation to the framing of the structure as the paper covering of a Japanese house—as it will be time enough, perhaps, to consider them when the system is introduced

here—there is still plenty of scope for discussion on matters with which we are more directly familiar.

Let us ask, then, first, how far are the definitions of Fergusson applicable to the conditions now existing when applied to the builder, the architect, and the engineer, where he says:—"The art of the builder consists in merely heaping materials together so as to attain the desired end in the speediest and readiest fashion (which of course includes the most economical). The art of the civil or military engineer consists in selecting the best and most appropriate materials for the object he has in view, and using these in the most scientific manner, so as to ensure an economical and satisfactory result. Where the engineer leaves off, the art of the architect begins. His object is to arrange the materials of the engineer, not so much with regard to economical as to artistic effects, and by light and shade, and outline, to produce a form that in itself shall be permanently beautiful. He then adds ornament, which by its meaning doubles the effect of the disposition he has just made, and by its elegance throws a charm over the whole composition. This division of labour is essential to success, and was always practised where art was a reality, and no great work should be undertaken without the union of the two. Perfect artistic and perfect mechanical skill can hardly be found combined in one person, but it is only by their joint assistance that a great work of architecture can be produced. A building may be said to be an object of architectural art, in the proportion in which the artistic or ornamental purposes are allowed to prevail over the mechanical; and an object of engineering skill, where the utilitarian exigencies of the design are allowed to supercede the artistic; but it is nowhere possible to draw the line sharply between the two, nor is it desirable to do so. Architecture can never descend too low, nor need it ever be afraid of ornamenting too mean objects; while on the other hand, good engineering is absolutely indispensable to a satisfactory architectural effect of any class. The one is the prose, the other is the poetry, of the art of building."

The interesting paper read by Mr. J. Nangle at our last meeting dealt with this poetical side of iron and brickwork construction, but such low class and dangerous ironwork is sometimes seen that the author is of opinion the prose aspects of builders' ironwork should be taken into consideration by the professions as soon as possible, in order that some sort of standard should be adopted below which the material and workmanship should on no account be allowed to descend. This is mentioned, like the matter of commission charges, in parenthesis, whatever may be the cause, whether competition, the absence of stringent and clear specifications, or some other influences, it is undoubtedly the case that most wasteful and atrocious girder work has been made, and in some cases condemned, in Sydney; but the subject in detail is beyond the scope of this particular paper.

Again, while it is certain that every architect who has been properly trained must have at least as much knowledge of civil engineering as pertains to ordinary domestic architecture, and that there are many cases where the thicknesses of walls, scantling of girders, joists and other timbers are practically settled by custom or building Acts, and also while we know that some architects do consult engineers in important matters of construction, themselves having civil engineering attainments of relatively high character, still is it also certain that the question of strength and economy of material is not always studied in larger and more important buildings as it might be. Take, for instance, the simple question of the thickness of walls in a lofty structure: if they were calculated out on a basis of the actual requirements, would there not be more uniformity and similarity than seems to be the case under similar conditions? When we see walls run up through storey and storey without any diminution, it would appear on the face of it that there must be either too much material above or too little below. There is no great harm, of course, in a little extra material above, but may we not ask ourselves the question—

Are there any cases where we think there is too little below? This leads us to another question, "Should more attention be given to structural conditions and the weights and stresses that have to be provided for, before the treatment is taken in hand, and should the architect, if he has not a trained practical engineer on his staff, consult or advise with an engineer on the special civil engineering portions of any considerable building?"

If Fergusson was right years ago, when he said that "Perfect artistic and perfect mechanical skill can hardly be combined in one person," the developments in the arts and sciences since his time must make its application to building construction much more forcible every day. It is very certain that no one engineer can be thoroughly acquainted with all departments even of civil engineering, and if he devotes his special attention for any time to engineering, as applied to the construction and equipment of buildings, he will probably soon develop into a specialist, and fall behind in other departments of his profession.

The foundation of an architect's training should be those great principles of fitness and beauty, which never alter, and which are as old and as lasting as the Eternal Hills. When an architect has made himself acquainted with all that the great masters of antiquity have done, has followed their successors through all the ages to the present time, and in such a way as to have assimilated that which is best to be learnt from them and their works, and having done that, has further so studied the requirements of our own days, that he can skilfully meet the utilitarian demands of modern buildings, and out of the store of knowledge laid up, and the training he has undergone, shed over them a halo of the most appropriate and beautiful ornament, it would almost seem as if he had done enough for one man.

An engineer, on the other hand, while working on scientific principles and laws, which no doubt are unchangeable in themselves, is confronted by ever-changing problems, which year by

year, and almost day by day, result from improvements on old, or the evolution of the entirely new processes and systems, which are constantly being introduced. So widespread and so manifold are the works now carried out by engineers that they are subdivided into an infinitude of branches, and in this way engineering differs considerably from architecture. One man may possibly be skilful in many styles of architecture while he excels in one of them, and at the same time have a good practical knowledge of the civil engineering of building construction, but no man could possibly be a universal engineer and have even a smattering of all that comes under the head of mechanical engineering.

On account of the wide use now made of iron and steel in building construction; the introduction of lifts or elevators into lofty structures; the application of machinery for heating, refrigeration, and mechanical or forced ventilation; it has now become the custom, and, in fact, a necessity, if success and economy are desired, for an engineer to be associated with the architect in all buildings of importance above a very moderate standard; and in reading accounts of buildings in other countries, we now see the name of the engineer as well as the architect mentioned. Recent particulars of the wonderful buildings of The World's Columbian Exhibition at Chicago show us that while the most eminent architects from the great cities of the States have been entrusted with the designs of buildings there, they were not responsible for the engineering construction, which in most cases was designed by Mr. Shankland. In the same way and for the same reason, architects and engineers have been associated in Sydney, both in the civil engineering of the structure and the mechanical engineering of its appliances and adjuncts, with, it is believed, most happy results and satisfaction to all concerned.

The public mind, it is certain, does not realise that every architect is more or less a civil engineer by necessity and training, otherwise his functions would consist of little more than

planning and ornamenting a structure. The diagrams of the great architectural authority already quoted, show where, in his opinion, engineering leaves off and architecture begins. It goes without saying, that where the use of machinery is the prime motive for the creation of the building, it should have the first consideration, symmetry and ornament following after, but in such cases where such a building has been put up without previous consultation as to the requirements of the machines and tools, there is generally a necessity to make a series of compromises, to incur additional expense, and to be content with a less satisfactory result on the whole than might otherwise have been the case.

In other cases of a similar nature the architect and the engineer go over the rough plans, and the latter indicates his requirements, say a pier here, an arch turned there: guides, pits, and foundations: and by mutual arrangement the least valuable space is sacrificed, and the best results secured, because, by the engineer clearly setting forth his requirements, the architect is able to embody them in his contract with the builder, and thus when the machinist (who has made his work to engineer's corresponding plans) comes on the ground, all goes smoothly together, and that heart-breaking cutting and carving of buildings that is so common is avoided.

Matters do not, of course, always work in this way, and several matters have recently come under notice, which it would not be wise to particularise too closely, because it is most desirable that no personal element should influence free discussion, and that principles only should be considered. These matters, however, have seemed to warrant an expression of opinion from those interested, for by such an open discussion it is possible that the good feeling towards one another which should characterise the members of our respective bodies may be maintained and strengthened. As is well known the author is an engineer, and has never practised as an architect. Many architects in Sydney never touch engineering works. Some

firms consist of both engineers and architects, and may be considered, thereby, perhaps more competent to express a disinterested opinion on subjects in which the two professions are involved.

The following cases which may, for our purpose, be considered hypothetical, are stated without colour, asking those present to discuss them and answer the questions propounded fully, in order that a general concensus of opinion may, if possible, be obtained for future guidance.

1. A Sydney mercantile firm was about to accept the tender of an equally well known engineering firm, for the supply and erection of several thousand pounds worth of machinery, in a nearly completed building, when the builder suddenly notified the principals that he would allow no such people on the premises except as sub-contractor to himself. Although it was matter of common knowledge that such machinery was required, and the architect had made certain preparations for it, the builder was able to have his own way, as there was no provision in the specification for engineering or other contractors to have access in the principal's interest.

Question.—Should all building contracts or specifications contain covenants that the proprietors may if they desire let any additional contracts for adapting or completing their building for its intended purpose, and that the building contractor shall give access to such other contractors so long as they do not interfere or hinder his work? (If the builder considers that he would be put to expense by this, he could add it to his tender, of course).

2. A firm of builders recently asked to be allowed to tender for many thousands of pounds worth of machinery to be erected in the colony, in competition with engineering firms, who never tender for building works.

Should such a tender be received and accepted if the lowest? If so, should iron trade firms be encouraged or even allowed to tender for buildings generally?

3. The steam machinery for a large building was let to a firm of ironmongers who sub-let to the actual local manufacturers.

Is it desirable as far as possible that the professional man, having the design and supervision of work like machinery should deal directly with the contracting manufacturers, especially where frequent supervision of the work should take place during construction ; or, should he trust the contractor to look after the sub-contractors ?

4. Tenders have on several occasions been invited and received for the supply and erection of extensive machinery plants, without any detail plans and specifications being supplied to intending contractors, and each contractor was left free to formulate a scheme and submit a tender on his own ideas of what was required.

Is it a consequence, and an actual fact resulting from such competition, that contractors instead of considering how good, and how appropriate a job they can supply, and tendering accordingly, know that such action would put them out of the competition, and that they actually consider instead how cheaply the work can be done so as to pass muster : and, therefore, as a result the permanent interests of the clients are entirely lost sight of ?

Is it a fact that numbers of such works made on contracts or specifications prepared by the contractors themselves and without expert supervision, have had to be either reconstructed or entirely thrown out ; and that new and properly designed plant has had to be substituted at great additional cost in several cases ? If so, is there any remedy to prevent such being repeated ? Again, is it possible to compare a number of different tenders for machinery or anything else of a complicated nature unless there is some basis for comparison ?

5. There have been cases where the builder has included in his building contract so many hundreds or thousands of pounds for the machinery of the building, and has asked the

machinery sub-contractor to include the usual 10 per cent. for him in the tender as the money is going through his (the builder's) hands. In such a case the principal or principals of course pay 15 per cent. instead of 5 per cent. only, as commission on the actual engineering contract, and the builder receives twice as much as the architect.

Is such an arrangement fair to the architect and to the engineering contractor, the one of whom received 5 per cent. for his professional services, and the other of whom often makes nothing at all through the roundabout method of business?

Does the client always understand that he is paying this 15 per cent. commission?

6. Contractors who have already executed many large plants of machinery have refused to tender for the machinery of a building because they were asked to allow 10 per cent. to the builder, and the general contract provided for the money passing through the builder's hands, as above. These engineering contractors did not see where they could make 10 per cent. for themselves with all the trouble and risk of the actual work having to pass through these extra hands, and they declined to tender at all under the circumstances.

Was such firm right or wrong?

Is it right that contracts for important works running into thousands of pounds for what should be specially-designed machinery, should be treated in the same way as bells, mantle-pieces, etc., etc., of no particular importance, or be left entirely to the manufacturer, without any regard to the interests of the proprietors of the building?

7. There are great and wide differences in the margin of strength, or factors of safety, perceptible in the construction of buildings, both in brick-work, and the columns, and the girders.

Is it desirable that more or less discretion as to strength and factors of safety than is now allowed to those responsible

for the designing of buildings, should be provided for in future legislation and Building Acts ?

Is it true that the design of girders for buildings is often in direct opposition to first engineering principles : that the workmanship is often exceedingly bad : and that the cost thereby often excessive for the actual strength ?

Is it desirable that a new Building Act should provide for the submission of all plans of stanchions and girders to an official, for approval, before they can be carried out, in the same way that designs for new steam vessels and boilers are examined by the Marine Board officers, and passed before construction is authorised ?

Is it desirable, and, if so, for what reasons, that the building contractor should be the sole contractor in connection with a building. And that all girders, lifts, heating and refrigerating appliances, electric lighting, etc., should be made through him : the actual contractors or manufacturers being sub-contractors merely, and only approachable by the architect or engineer through the builder ?

Is it desirable that the practice of inviting tenders on skeleton descriptions, under which the contractor has to supply the actual plans and specifications, should be encouraged ?

Would it be a good thing, if it were to become the custom for persons desirous of building, to furnish a plan of the ground, and a skeleton list of their wants, asking builders to tender for the building, supplying complete plans and specifications of what they propose to supply ?

If it is to be the practice for builders to supply tenders accompanied by plans and specifications for the building, and the complete mechanical equipment of banks, stores, insurance offices, hotels, etc., where are the architects and engineers to come in ?

In conclusion, the very short time that has elapsed since

the writer was requested to write this paper must be the apology for its many deficiencies, but he trusts it will be discussed with the same friendly spirit in which it is written.

DISCUSSION.

Mr. G. A. MANSFIELD, in opening the discussion, said he considered that unless an architect possessed sufficient engineering knowledge to enable him to correctly design the ordinary iron-work which might be termed an integral part of the various structures with which he had to deal he was not qualified for his duties. There were many matters connected with the design and construction of elevators, electric lighting and motive plant, &c., for all the numerous requirements met with in large buildings which were of a purely engineering character, and in such cases it became the architect's duty, in justice to himself and his client, to import into his work that special knowledge which alone could deal satisfactorily with these questions. He (the speaker) had had to do this on several occasions, and so far there had been no clashing of interests or conflict of opinions. It had been his good fortune to meet with gentlemen with whom he could act in accord and with very satisfactory results. With regard to the author's first question he (the speaker) could scarcely imagine a case in which an architect would draw up his specification and conditions so loosely for an important contract as to place himself at the mercy of the builder. If such a trouble ever came to his (the speaker's) lot he would be very unwilling to allow a contractor to assume such a position without contesting the