BETTER BY 3D DESIGN AND COORDINATION IN BUILDING SERVICES INDUSTRY

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Do a 2-Dimensional (2D) design reaches the end of useful life? Actually, as the approach of a new computerized era, Building Services (B.S.) Industry becomes more complex and sophisticated than before. Each discipline within the building not only coordinates in a right and proper order, but also requires meeting the target date without any economic loss. Designing in a 3-Dimensional (3D) approach is the trend. It is the future of our presentation of design concepts in each industry, particularly in B.S. disciplines. Designing in 3D is already finding favour amongst many engineers and architects.

I. Analysis in B.S. Industry

For Design Stage

A building project starts with inception and feasibility study. When the client decides to proceed, the design stage commences. The design team, usually led by the architect appointed by the client, is responsible to design a building which fulfills the requirements of the client set out in his brief. Typically, the design of a building includes architectural design, structural layout and services design, which are carried out by different professionals. These various aspects of design are closely related to each other. For an instance, the size or location of a plant room affects the floor layout and is also influenced by the constraints set by the structural requirement.

Moreover, the final design solution must be able to satisfy the client's need regardless of the conflicts in design by different professionals. Also, if the client wants to keep the floor height as low as possible to maximize the number of storeys of the building, while the false-ceiling zone must be able to accommodate necessary services such as air conditioning systems, fire services installations, lighting conduits and drainage pipes. Therefore, the coordination of each role related in the project is very important.

Achievement of a Good B.S. Coordination During Design Stage

As mentioned before, the design of a building requires the preparation of different types of drawings including structural, architectural and services drawings. It is important that integrating various services into a building fabric correctly. There are several principles in the achievement of successful services integration:

- Coordination with Design Team;
- Coordination of Various Services Drawings;
- Preparation of Combined Services Drawings.

For Construction Stage

After the design team has prepared the design of a building, it is the responsibility of the contractor to turn the design into built form. Basically, the construction process can be divided into several stages related to the main building elements: substructure, superstructure, external finishes, services installation and internal finishes. These aspects, however, to a certain extent overlap so that the construction process in reality consists of highly interdependent activities, which must be well planned in advance and coordinated. The coordination of services may be both essential and complex depending upon the complexity of services installation.

Achievement of a Good B.S. Coordination During Construction Stage

There are 3 main ways to achieve Good Building Services Integration during Construction Stage:

- Main Contractor's B.S. Engineer/ Coordinator;
- Coordination meetings with Nominated Sub-Contractors;
- Preparation of Combined Services Drawings (CSD) & Combined Builder's Work Drawings (CBWD).

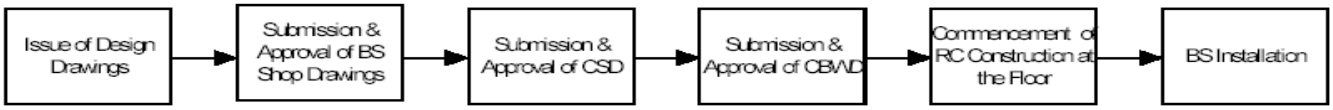
II. Typical Barrier/Constraints arisen in B.S. Coordination

Many constraints/ barriers have been found to act on the process of coordination of design schemes for building services and these are generally as a result of basic differences existing between the services disciplines.

Communication - Initially there is a general communication problem. Each of the services disciplines has tended to operate separately and has developed its own drawing type, notation, standards and its own specialist language. However, in the process of co-ordination the information produced must be meaningful to all disciplines. Many problems can occur by the wrong interpretation of information both at the design and construction level.

Services Drawings in Traditional Ones (2D) - The normal means of communication between the designer and installer is by drawings. It is in this area that one of the major differences and problems exist when transferring information across disciplines. The basic concept of the drawings varies with the disciplines.

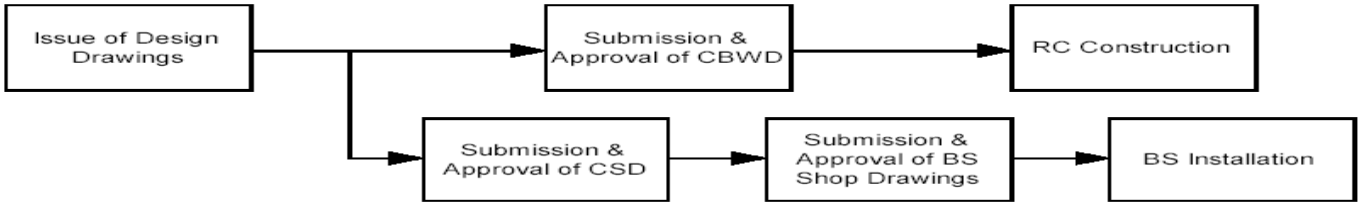
Differences between the disciplines are found in the nature of the working drawings produced by the installation contractor. Mechanical and Electrical services drawings are generally a development of the tender drawing including details of plant and equipment, which were left at the design stage for the installer's selection. Working drawings normally also include builders work details of bases, holes and the like. Working drawings provided by the electrical installer are normally limited to manufacturer's drawings and wiring diagrams for major plant items. It is unusual for working drawings to be provided for the general electrical scheme and installation is normally carried out using the tender drawings.



Flowchart of BS Drawings for One Specific Floor

It can be seen therefore that just the transfer of information by way of drawings with their differing notation and standards can impose a problem when considering communication across services disciplines and impose a restriction when considering co-ordination.

Design Flow - A further area which needs to be considered is the design procedure, and in particular the time available during the design for co-ordination. It has been found during the course of this study that the time available for design is limited. This is usually as a result of either pressure by the client for speedy construction, which occurs particularly with speculative built office blocks where protracted design and construction periods can lead to loss of revenue, or it can be the result of restricted time periods imposed by the services design practice to ensure maximum effort by designers or to meet high work load. Whichever of these apply, the restriction imposed on the design periods limits the available time for co-ordination between disciplines.



Practical Sequence for BS Submission

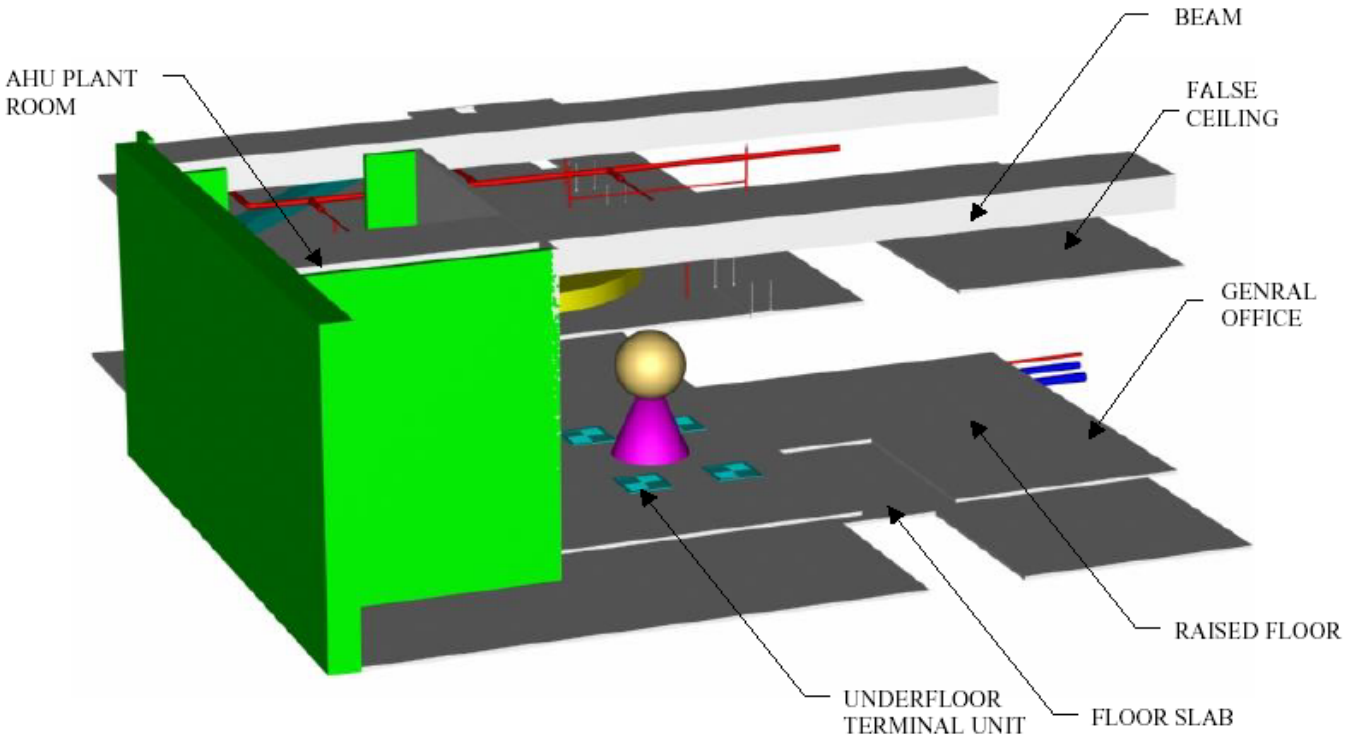
In general it is found that this information is not available to a common time scale and that to enable designs to develop, a decision is made on the terminal device position without full consideration for other services.

It would be desirable for further studies to be made-of the design process to find if a sequence of design exists which will enable the information necessary for co-ordination to be made available at a similar time.

III. Discussion

Advances in electronic communication have changed our industry enormously. Today, architectural or engineering drawings have evolved from CAD "dumb" images to the emerging field of 3D drawings and designs.

These "smart" drawings and designs carry full intelligent in every line and object. The ultimate benefit is that 3D manner can provide the human being with a live scene of every element that goes into the building actually.

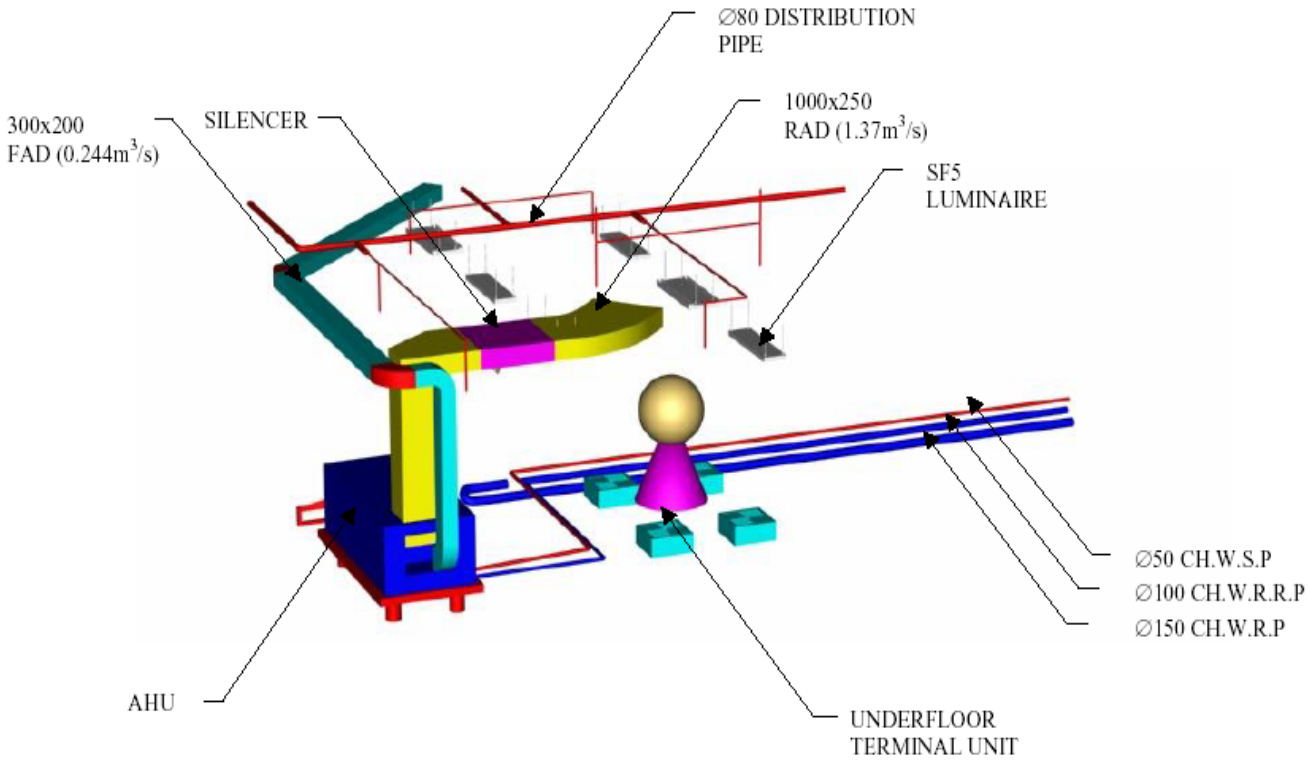


3D View of AHU Plant Room and Nearby General Office

Comparison between 2D and 3D

Here is a comparison between 2D and 3D, what full development of 3D approach can bring (use of AHU Plant Room of Tradeport Logistic Centre): -

1. Provide visualization of project;
2. Build fundamental intelligence into drawings;
3. Improve issue-tracking process of each service;
4. Facilitate off-site prefabrication;
5. Improve field coordination;
6. Eliminate interferences;
7. Provide client with live appearances;
8. Save cost and time by minimizing messy clash with different services;
9. More artistic rendering effect of presentation;
10. Preliminary Clash detection and prediction.



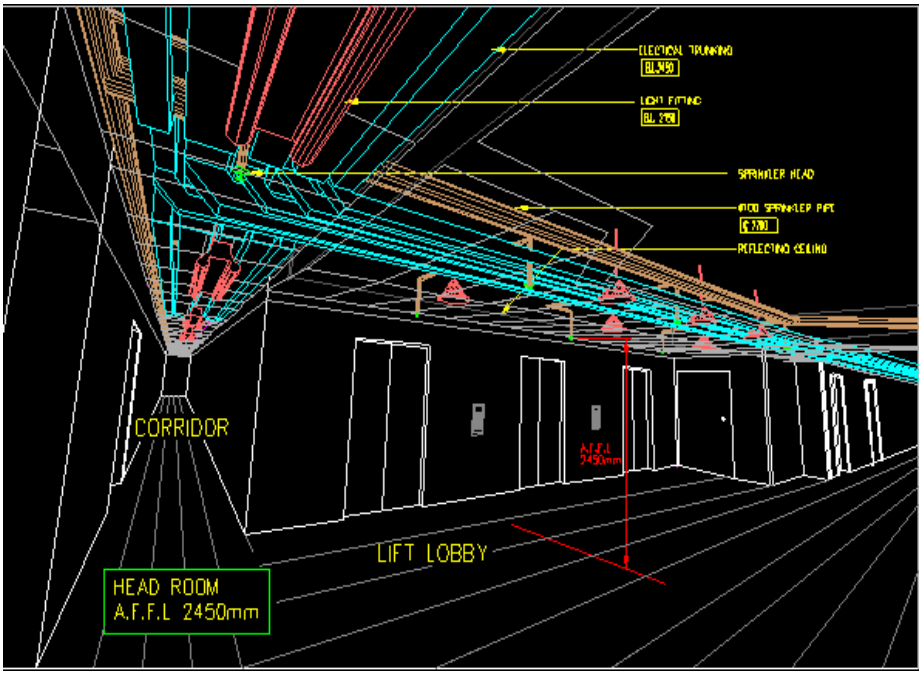
3D View of AHU Plant Room without Walls & Raised Floor

Surely, 3D manner still has its demerits as follows: -

1. Relatively large initial investment;
2. Requires training of management and operative staff.
3. Difference in drafting concept requires change in working pattern.
4. New technology requires acceptance within the organization.
5. Training of CAD operators and management staff increase operation costs.

Space the final frontiers?

Construction will not embrace 3D CSDs/ concepts until the right products are available for its particular needs. Imagine being able to walk around a building before it is built. Imagine being able to show a client exactly what the end product is going to look like before you have even begun work on site. Imagine, instead of poring over endless 2D drawings, having the whole project, including architectural, engineering and mechanical and electrical detail, on one model. This is the promised land of 3D approach. It has already been in use in other industries, such as the petrochemical industry, for more than a decade and is slowly but surely finding its way into construction.



3D AutoCad Drawing of Typical Lift Lobby

3-Dimension (3D) or not?

Construction has been slow to adopt 3D CSD. But could it work as well for construction as it does for other industries? People always argue the case for applying 3D approach. CAD systems come in essentially three flavours. The one you choose depends on what you are designing. Far and away the most common across both the mechanical and the construction industries are 2D systems such as AutoCad or Microstation, in which the fundamental input is a line. Join some lines together and you get a drawing. Most 2D systems today also have a parametric capability where a drawing can become a template from which a family of similar drawings can be easily generated. And that is about it for 2D – totally flexible and essentially stupid. If we want to create a beautiful 3D picture of our project we use a special visualization program, which can often do animation and other clever things.

Importantly, the main benefit of assembly 3D – design integrity – was highly valued by the industry. Not surprisingly 3D manner soon become the world market leader in CAD systems for plant design and changed the industry in the process.

IV. Conclusion

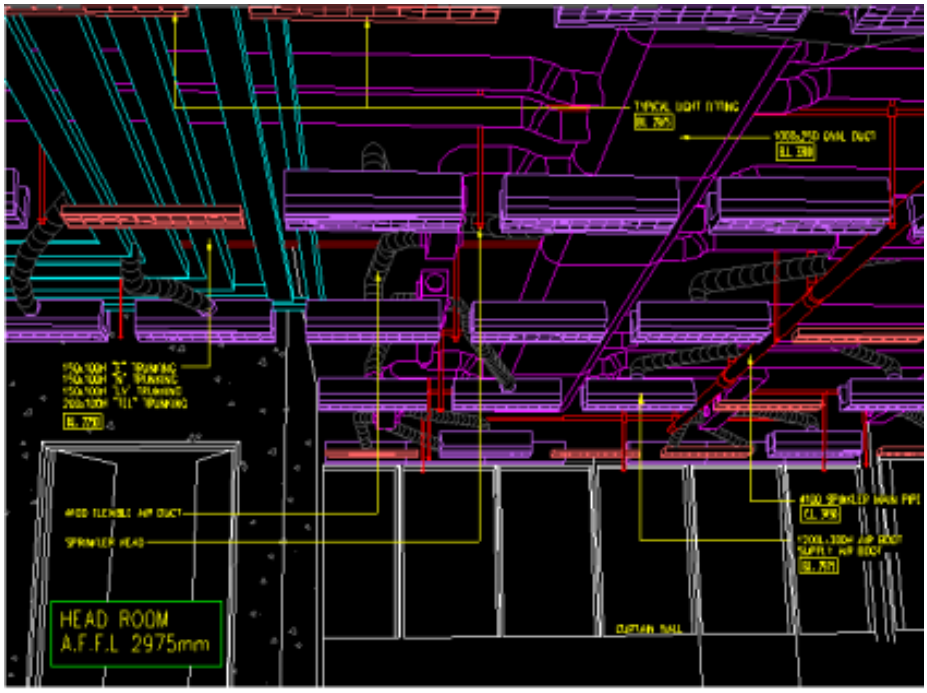
This article has been an overview of the procedures and problems associated with the co-ordination of building services at the design and construction stage. The major problem to be isolated and the problem upon which all other decisions are based is the question of cost effectiveness of co-ordination. Thinking and designing in 3D approach is a must.

If additional costs are to be incurred at the design or construction stage by virtue of the co-ordination of services and the production of detailed coordinated information, comparative savings must be made. These may be in the form of reduced contract delays, reduction of extra costs associated with the modification to services as a result of non co-ordination, or the eventual reduction of tender values as a result of problem-free installation. Only if saving in excess of co-ordination costs can be foreseen can a client be reasonably expected to include co-ordination as a part of a services design commission. These comments apply equally well to the contracting sector insofar as a contractor will only carry out coordination if the cost is comparable with the savings to be made during construction.

In previous sections, the need for integration and coordination of services during both design and construction, current methods of achieving integration and coordination and associated problems have been discussed. The reasons for the need of 3D way for building services integration and coordination are shown in the study. Delay in completion of the project can be prevented and abortive work, and hence expenses, reduced. Moreover, good access to services installations for future maintenance is provided.

It is the time we need to fundamentally change our approach by incorporating these 3D design technologies. It is our responsibility to educate the other' parties in the construction industry, as well as building and plant owners, of the potential benefits that a unique 3D approach can bring. Ultimately, building owners will benefit most. However, they must first recognize the potential and then support the higher cost of the initial design process. It will take a substantial investment in new technologies, cooperative teamwork, commitment and recognition of the total picture. With cultural change, and industry change, not the least challenge of which is persuading contractors and suppliers to accept the design in 3D.

In summary the improvements in development and speed of traditional 2D approach, although staggering, are not enough. Technology is no longer the inhibitor to our progress. In fact, technology is already ahead of our ability to digest, and process. What is needed is an upfront change in the design and construction process. Three-dimensional drawings are one tool for our industry to use.



3D AutoCad Drawing of Typical Office Area

Frankly speaking, much more should have been discussed in order to have a thorough investigation and presentation of the applications of 3D CSD to the B.S. industry. I believe that this paper not only give a clear picture how to make coordination and integration well in B.S. industry, but also raise the idea/ concept to apply 3D way in our industry.

V. Acknowledgements

I would like to express my heartfelt thanks to those people who had assisted during my work, especially Ir. Dr. Albert So (Associate Professor) of City University of Hong Kong and Ir. Patrick Lui (Construction Manager – M&E) of Gammon Skanska Ltd., who provide me invaluable help throughout the whole article.

VI. References

Adrian M. & John O. (1982). Co-ordination of Building Services – Design Stage Methods. Building Services Research and Information Association.

Anthony R. & Garry S. (1987). CADD Made Easy - A Comprehensive Guide for Architects & Designers. USA, R.R. Donnelley & sons Company.

Andy L. (2000, Jan 07). Smart design**.** IEE Journal [Online]. Available: http://www.iee.org/pn [2003, January 12]

Gray C. (2000, November). 3D or not 3D? IEE Journal [Online]. Available : http://www/iee.org/pn [2002, August 28]