ANALYSIS OF BUILDING PRODUCTION DRAWINGS

Peter Scher B.A. (Arch) A.R.I.B.A.

Associate
George/Trew/Dunn, Chartered Architects
London, England

Introduction

For a generation now there has been overwhelming interest in those aspects of design which are the subject of dramatic and rapidly accelerating change. This interest has been expressed naturally in enthusiastic speculation, experiment, innovation, reports, articles, books, broadcasts, conferences and even, latterly, in research. Think of Urban Planning, Industrialisation, Transportation, Environment Control or Electronic Data Processing.

Meanwhile back at the office designers still draw - much as they always have done. To trained architects in particular drawing is second nature and once learned is a form of communication as unselfconscious as the use of words. Because we are almost unaware of oursevles drawing and because in practice drawing is not changing dramatically and rapidly it has not been given much attention.

Studies in Communications have proliferated, but always the Ugly Sisters, Word and Number, have been pampered excessively while the beautiful Cinderella, Drawing, has been scorned and neglected. No attempts appear to have been made to carry out systematic studies of the nature of drawing as an activity or of the natural history of the drawings in use around us themselves. We recognise that drawings are not independent of other forms of "communication" used in our work but they are so basic and special to the activity of designers that they fully warrant objective study in their own right.

A completed building is, among other things, the product of a design which has been first expressed by means of drawings. Yet only on completion is it safe to say that no more drawings are needed. It should not be necessary to finish the building in order to establish what drawings are needed for its construction.

It was our wish to predict more accurately the nature and number of drawings for projects before completion - in fact, before construction - that led to our first studies in drawings.

Objectives

Our studies had three objectives:-

1. To survey all the drawings prepared and used for a completed project.
   As far as we could ascertain this had never been done before
2. To identify any significant relationships within the survey data.
   Although we expected most of these to be unique to the project we foresaw that numerical data could form a useful basis for comparison with other projects.
3. To establish a method of checking that all necessary production drawings for a project have been prepared.
   In practice some extra drawings seem to be required on every job during construction and not all are due to unforeseen snags. The general intention for most of our projects is to complete virtually all drawings before building starts and we were seeking a procedure for ensuring this.

We first undertook a study of the drawings for a new Secondary (High) School. The results proved so interesting that we followed it up with a matching study of the drawings for a new Maternity Hospital. This was aimed principally at obtaining a second set of data for comparison but also at identifying differences in drawings determined by the building type.

Method

We did not study the drawings of either project until six months after the buildings were in use. For both projects we examined every drawing available. Many design sketches were by then no longer in existence. However we were satisfied that only a very few, if any, drawings issued to the contractor, sub-contractors or suppliers for the purposes of construction (i.e. working or production drawings) escaped examination. If one or two did 'get away' their effects on the data would certainly be marginal.

We scheduled the following data about every drawing:- Office of Origin; Category (i.e. Design or Production (Working) Drawing); Drawing Number; Last Revision; Full Title (clarified if necessary); Size; Scale(s); Stage (RIBA Plan of Work) of Origin and of each Revision; Content Group classification(s); Errors in Basic Data (Information in Title Panel, etc.)

The Two Projects

The first project is an eight-form entry mixed comprehensive school for a local authority. Its development was on an existing suburban school site involving decanting, sectional completions and the retention and up-grading of one existing block. Progress throughout the duration of the project was satisfactory and all target dates were met.

TABLE 1 - PRODUCTION DRAWINGS AND REVISIONS	SCHOOL PROJECT		HOSPITAL PROJECT	
OFFICE OF ORIGIN	Total Drawings	Total Revisions	Total Drawings	Total Revisions
1. ARCHITECTS	411	905	365	385
2. CLERK OF WORKS - Site Instructions with drawings	11	-	8	-
3. DRAINAGE CONSULTANTS	54	107	63	27
4. STRUCTURAL CONSULTANTS (Bending Schedules)	526 (336)	468 (191)	223 (161)	51 (39)
5. M. E. CONSULTANTS	44	69	31	95
6. E. E. CONSULTANTS	34	17	57	244
7. LANDSCAPE CONSULTANT	2	-	-	-
8. LOCAL AUTHORITY (Roads)	-	-	2	-
9. STATUTORY UNDERTAKINGS - Telephones - Electricity	1 3	- -	- -	- -
10. CONTRACTOR (of these, 36 drawings were copy negatives of S. E. Consultants' drawings used for co-ordination of holes, etc.)	-	-	42	7
11. SPECIALIST SUB-CONTRACTORS, SUPPLIERS, etc. Contract Drawings issued excluding drawings, if any, not issued to design team.	64	36	201	68
TOTAL PRODUCTION DRAWINGS AND REVISIONS	1150	1602	992	877

The total floor area is 103,080 sq. ft. (new buildings) plus 24,605 sq. ft. (up-graded existing building). Estimated final account is £680,000 (new building) plus £52,500 (up-grading existing building). Work on site began in September 1966 and completed March 1969.

The second project is the Maternity Unit of a new District General Hospital for a Regional Hospital Board in the South of England. It is typical of many such units required throughout Great Britain under the 1962 Hospital Building Programme. The Unit contains 96 maternity beds, 6 delivery rooms, 2 operating rooms, a special care baby unit of 20 cots, an Ante-Natal Clinic and a Teaching Department for pupil midwives.

The site, open and landscaped, is in grounds of an existing 19th century mental hospital, just outside a provincial town. There were no sectional completions but handover was complicated by late changes in the brief involving temporary additions and conversions. The contract was completed three months late and progress throughout pre-contract stages was never entirely satisfactory for a variety of reasons. The project forms the first stage of a very much larger hospital development.

The total floor area is 78,250 sq. ft. Estimated final account of £672,300. Work on site began in March 1967 and completed in June 1969.

Both projects are well-defined but by no means standard building types and both were designed and built within the normal cost limits set by central government departments. Both building contracts were let by selective competitive tender on full bills of quantities.

Drawings and Revisions

Because we had not been able to examine all design sketches this study was concentrated on the production drawings. The bulk data is given in TABLE 1 for drawings and for indexed revisions. FIGURE 1 compares the proportional outputs of drawings graphically. (Both projects had structural frames of reinforced concrete and Bending Schedules were made. Because they form such a large group of drawings numerically they are identified in tables and figures to show their effect.).

The most striking aspect of Table 1 is the comparison of totals. While the hospital is 39% smaller than the school in floor area the number of drawings is only 14% fewer and the cost only 9% less. There is another striking difference in the total of revisions and this is discussed below.

In Figure 1, although the architects' share of the total is almost the same for each project, the other differences are of great interest, particularly the contributions from structural engineers, and the specialist sub-contractors.

Drawing Sizes

The apparentlyoverwhelming significance of the A4 size Bending Schedules for the school project is a clear indicator that number of drawings is a relatively crude measure and that amongst other things the size of each drawing may indicate its real or potential importance.

The range of drawing sizes in both projects included every standard traditional size, A1, A2, A3 and A4 standard sizes and an extensive variety of random non-standard size drawings - from 10" x 8" up to 67" x 28". The distributions are shown on FIGURE 2.

FIGURE 3 shows the proportional output of production drawings (figure 1) converted to areas and supports the view that total area is almost certainly a better index than total number of drawings. The bending schedules are reduced to their proper significance and the architects' drawings for both projects are seen to be the biggest single group.

The biggest differences between projects are, first, in the structural drawings which are directly related to floor area and second, in the drawings of specialist sub-contractors, which are directly related to the complexity of the services.

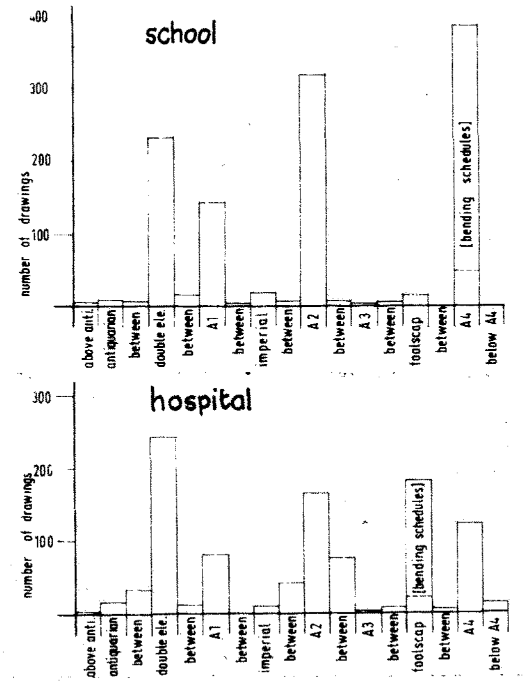


FIGURE 2
Paper sizes used for production drawings

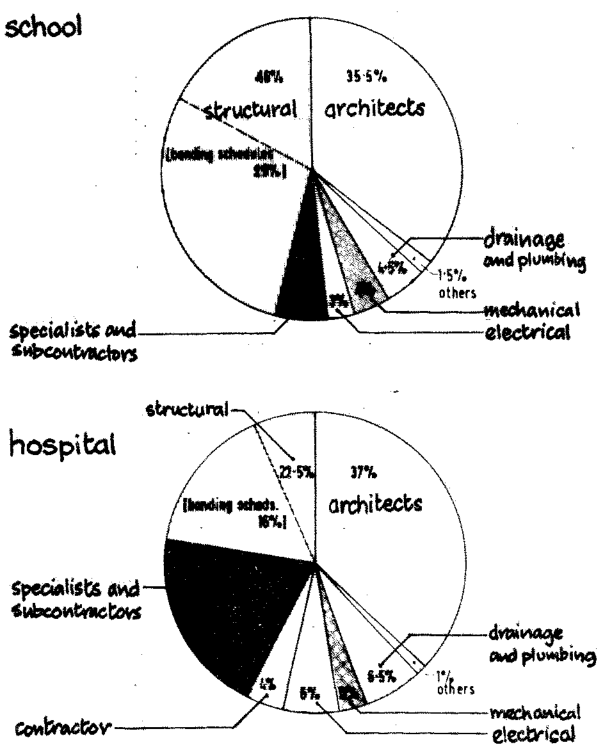


FIGURE 1. Proportional output of production drawings by numbers of drawings

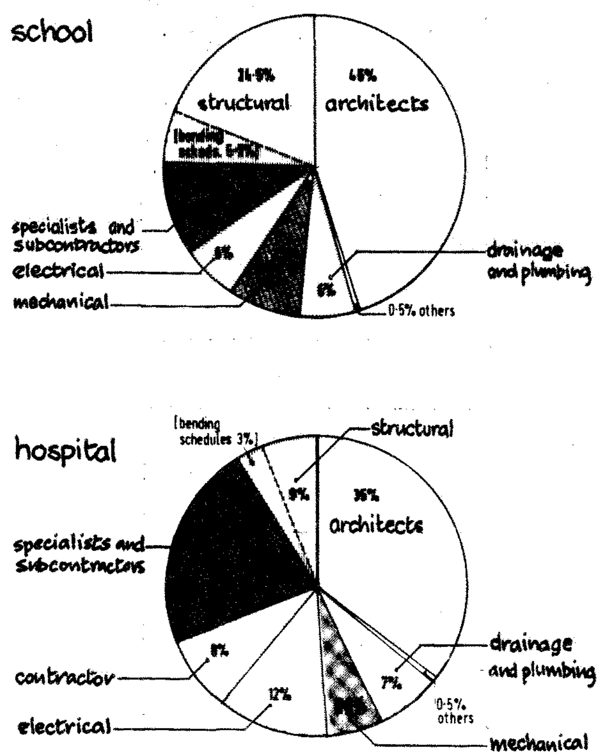


FIGURE 3. Proportional output of production drawings by area of drawings

"Revisions"
Perhaps the most interesting results of all came from the analysis of revisions. Up to now their significance has been largely unrecognised yet our earlier studies indicated that at any given moment perhaps one third of our staff were altering drawings rather than making new ones. For the purpose of these studies we counted each indexed revision on each drawing as a single "revision". The term, of course, covers any difference between two versions of the same drawing. Often it represents the addition of further information or detail, the drawing having been issued for some purposes during the planned process of its completion. A drawing may also be "revised" because what it shows has to be changed or contains a genuine error. Again a 'single' indexed revision can, and for convenience often does, summarise additions, omissions, changes and/or corrections. From Table 1 there are seen to be far fewer revisions overall for the hospital than for the school. Compare however the figures for the Electrical Consultants on each project. For the school they revised their drawings least of all (on average 0.50 revisions per drawing) and indeed stamped all their production drawings "Provisional drawings only". For the hospital the Electrical Consultants revised their drawings most of all (4.28 revisions per drawing) recording each change meticulously.

By chance we seem to have observed two extremes of acceptable drawing practice here. Other important differences in practices were seen - for example Structural Consultants for the hospital made new supplementary detail drawings rather than revise existing ones; for the school the architects deliberately planned the issue of certain drawings at staged completions and these planned revisions accounted for 262 of the total 905. But for the effect of these differences in practice the frequency of drawings with none, one, two revisions etc., would appear to follow a Poisson Distribution as can be seen in FIGURE 4. This distinct pattern suggested that the revisions to drawings might be a reliable guide to many significant features in any set of drawings.

Content Grouping
Each group of these two projects generated around 1,000 production drawings and in each case the architects' share was only just over one third of them. To obtain a general understanding of such a large set of individual drawings we need to see a pattern of larger groups within it. It was thought that by grouping these drawings according to content the set's structure would be further illuminated. For this purpose we used the only "standard" available, British Standard 1192 : 1969, "Recommendations for Building Drawing Practice". This groups drawings by their content in the Production Stage as Location (with 3 sub-classes), Component (with 2 sub-classes) and Assembly drawings. The standard also refers to "Schedules" and to "Standard Details". We attempted to group the drawings for the school project by this method but the allocation was difficult, due no doubt to the fact that the drawings were not made originally with the BS groups in mind, and the results proved of little interest.

But the most significant structure of the sets had already been indicated and is recognised almost unconsciously by all members of the Building team. The first characteristic of any drawing to be 'read' - automatically - is its office of origin. The set of production drawings comprises a number of sub-sets each

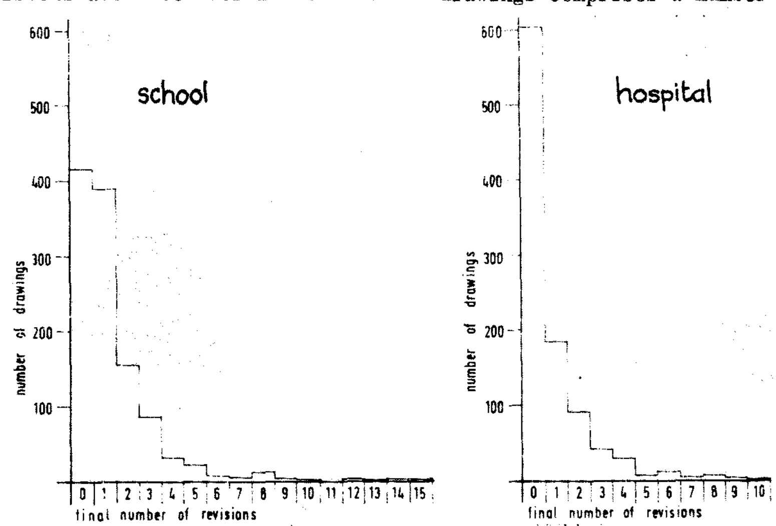


FIGURE 4.
Final revision numbers of production drawings

TABLES 2 & 3 - CONTENT GROUPS OF ARCHITECTS' PRODUCTION DRAWINGS
RANKED BY AVERAGE REVISIONS PER DRAWING

Rank	Content Group B.S. 1192 classes shown in brackets - Location (L), Assembly(A), Component(C) and Schedule(S)	No. of dwgs	No. of revs.	Average r/d	Scale LS = Large Scale (greater than ¼" to 1')
SCHOOL					
1.	Floor Layout Plans (L)	25	214	8.60	¼" to 1'
	(excluding three planned revisions to each drawing)	(25)	(139)	(5.60)	
2.	Door Schedules (S)	13	68	5.23	-
3.	Site Plans (L)	2	9	4.50	1/16" to 1'
4.	Furniture Layouts (L)	16	71	4.43	¼" to 1'
5.	Schedules of Architects' drawings (S)	2	8	4.00	-
6.	Roof Plans (L)	5	16	3.20	¼" to 1'
7.	Mounting heights diagram for fixtures (L)	1	3	3.00	½" to 1'
8.	Typical Sections (L)	7	20	2.86	¼" to 1'
------	(overall mean for set)			(2.20)	
9.	Key plans and elevations (L)	8	15	1.87	1/16" to 1'
10.	External wall, window and roof details (A&C)	24	41	1.71	LS
11.	Reflected Ceiling plans (L)	16	27	1.68	¼" to 1'
12.	Door frame assemblies (A)	6	10	1.67	LS
13.	General interior detailing (A&C)	59	78	1.36	LS
14.	Staircase Layouts and details (L&A)	5	6	1.20	¼" to 1' & LS
15.	External Works details (L, A&C)	11	13	1.18	LS
16.	Building Programme (-)	1	1	1.00	-
17.	Room Data Sheets (L)	187	298	1.58	¼" to 1'
	(excluding one planned revision to each drawing)	(187)	(111)	(0.58)	
18.	Site Record drawings (L)	2	1	0.50	1/16" to 1'
19.	Schedules of furniture, fittings and equipment (S)	21	6	0.29	-
	TOTALS AND OVERALL MEAN	411	905	2.20	

Rank	Content Group B.S. 1192 classes shown in brackets - Location (L), Assembly(A), Component(C) and Schedule(S)	No. of dwgs.	No. of revs.	Average r/d	Scale LS = Large Scale (greater than ¼" to 1')
HOSPITAL					
1=	Mounting heights diagram for fixtures (L)	1	3	3.00	½" to 1' (LS)
1=	Typical Sections (L)	1	3	3.00	⅛" to 1'
1=	Schedule of furniture, fittings and equipment (S)	1	3	3.00	-
4	Floor layout plans (L)	23	59	2.57	¼" to 1'
5	Site plans (L)	9	18	2.00	1/2500, 1/500 1/16" to 1'
6	Reflected ceiling plans (L)	14	23	1.64	¼" to 1'
7=	Key plans and elevations (L)	24	32	1.33	1/16" to 1'
7=	Door Schedules (S)	3	4	1.33	-
-------------	(overall mean for set)			(1.01)	
9	Door frame assemblies (A)	13	13	1.00	LS
10	External wall, window and roof details (C&S)	48	46	0.96	LS
11	Room data sheets (L)	156	146	0.92	¼" to 1'
12	External works details (L, A & C)	9	7	0.78	LS
13	Schedules of architects' drawings (S)	2	1	0.50	-
14	General interior detailing (A&C)	55	26	0.47	LS
15	Staircase layouts and details	4	1	0.25	¼" to 1' & LS
16=	Site record drawing (Survey) (L)	1	-	0.00	1/1250
16=	Structural co-ordination (L)	1	-	0.00	⅜" to 1'
	TOTALS AND OVERALL MEAN	365	385	1.01	-

defined by an office originating drawings. Table 1 illustrates this but note that the drawings grouped together under item 11 are not a single but sub-set but originate from 14 different firms for the school and 23 for the hospital.

Nevertheless the larger sub-sets - in particular the architects' drawings - are capable of further structuring. The architects' drawings for both projects were grouped following our own standard method and some interesting results were obtained. The school was the first project to be analysed and since we were already aware of the significance of revisions we examined the number of revisions made to drawings in each content group. The average number of revisions per drawing for each group was calculated and when these values were used to rank the groups the results shown in TABLE 2 proved highly interesting. The hospital project, as already noted had far fewer revisions to drawings overall, yet when the same analysis was made it gave strongly confirmatory results, TABLE 3.

The three 'groups' ranked 'first equal' for the hospital are all single drawings and not as significant as they appear. These aside, the overwhelming importance of the floor layout plans in both sets is clear and will be confirmed in the experience of most practitioners

The overall average divides the sets into two. above the mean of both sets there are no large scale drawings and no 'assembly' or 'component' drawings (BS 1192). Site plans of both projects were revised above average, as were also the door schedules - an unpopular and intractable category of drawing. More complex services accounted for the higher rank of ceiling plans in the hospital set.

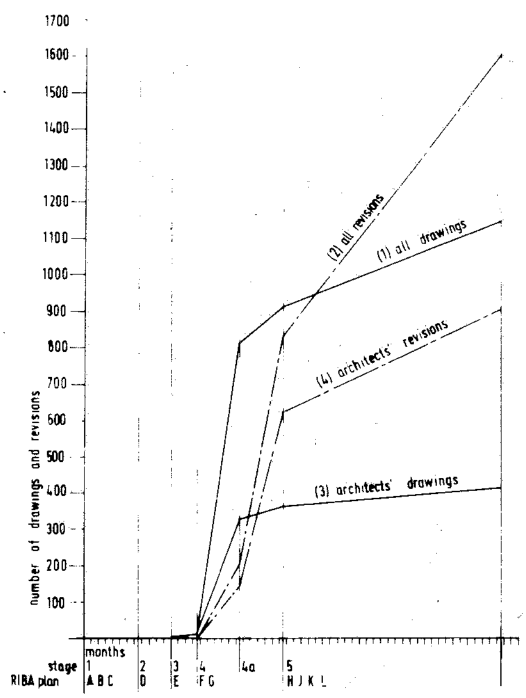
These tables reflect many other significant features of the projects and the drawing procedures, e.g. revisions generated by changes in the brief for the hospital, and the planned revisions for the school. Clearly therefore it is of value to define content groups and use them for preparing sets of production drawings.

Pattern of Origin and Revision

To throw light on the problem of how to ensure sets of production drawings were completed we counted drawings and revisions originating within each stage of the projects (1). The project programmes are compared in TABLE 4 on the next page.

Stage 4a was defined to assess how well the design team for the school achieved the aim of completing all drawings for inclusion in Bills of quantities.

The results are shown on FIGURE 5 for the school and FIGURE 6 for the hospital as a cumulative frequency diagram to a time scale. The steepness of the graphs indicates intensity of output by drawing offices. For example the architects'



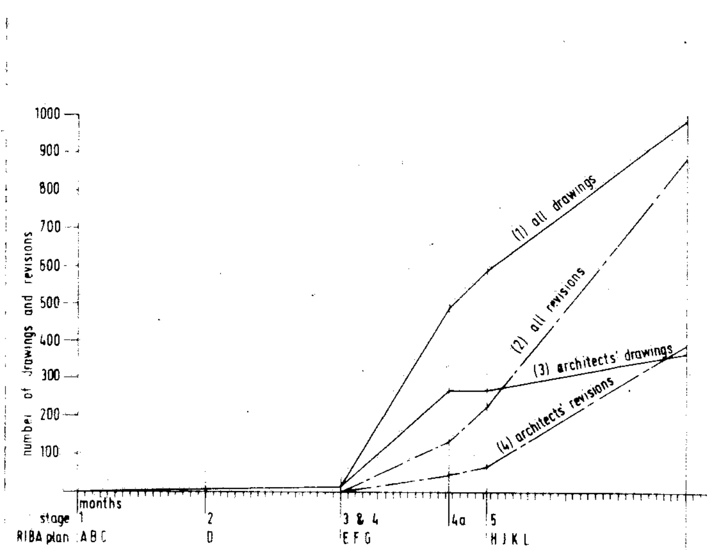


FIGURE 5 - SCHOOL

FIGURE 6 - HOSPITAL

Cumulative frequency curves for production drawings and revisions by stages of origin.

TABLE 4 - COMPARISON OF PROJECT PROGRAMMES

Stage (RIBA Plan of Work)		Duration in Months School	Hospital
1.	Outline Plan (A, B and C)	$7\frac{1}{2}$	17
2.	Sketch Design (D)	$4\frac{1}{2}$	18
3.	Preliminary Working Drawings (E)	$3\frac{1}{2}$	$14\frac{1}{2}$
4.	Final Working Drawings (F and G)	6	
4a.	From final issue of drawings to QS for measurement and inclusion in bills to start of work on site (G).	6	5
5.	Contract Supervision (H, J, K & L)	30	$26\frac{1}{2}$
	TOTAL	$57\frac{1}{2}$	81

output during Stage 4 for the school project was 318 production drawings and 146 revisions. Office records showed that during this stage there was a full-time team of four. Thus their average combined output was 2.65 new drawings and 1.22 revisions every day for 6 months (120 working days).

The reasons for new drawings being made in Stages 4a and 5 were analysed but it did not prove possible to analyse reasons for the revisions. The slope of the graph for the hospital shows that the rate of revisions to drawings was greater in number for the hospital than for the school. The actual numbers were as follows:-

Stage 5 new drawings -	51 ($12\frac{1}{2}\%$)	School
	97 ($26\frac{1}{2}\%$)	Hospital
Stage 5 revisions	283 (31%)	School
	318 ($82\frac{1}{2}\%$)	Hospital

Discussion

Knowledge gained from these studies illuminates three areas.

1. The projects, as such.

It is widely recognised that hospitals are more complex, more costly per unit floor area, take longer to design and build and in general are more 'difficult' than most other building types. Analysing complete sets of drawings for a school and a hospital have confirmed this with precise data in a number of ways, TABLE 5.

TABLE 5 - COMPARISON OF KEY CRITERIA

	School	Hospital
Briefing and Design period	12 months	35 months
Production Drawings period	$15\frac{1}{2}$ months	$19\frac{1}{2}$ months
Office originating drawings	23	30
Ratio of Area of drawings/Floor Area of Building	0.031	0.052
Ratio of Building Cost/Floor Area of Building	115/- per sq. ft.	172/- per sq. ft.

Other indicators of the 'difficulty' of the hospital were the greater range and variety of scales and drawing sizes, more errors in basic data and more drawings and revisions made during construction. Always remembering that the hospital was a smaller building.

2. The drawings, as such.

Section 1 of BS 1192 claims to.... "give guidance on the production of building drawings so that information is communicated accurately, clearly, without repetition and with economy of means.". No-one can disagree that building drawings should be so produced. In the course of these two studies well over 2,000 individual drawings were examined. A large number were accurate, clear, without repetition and executed with economy of means.

A number were not, however, and some were so poor they could only be described as sub-professional, for in drawing practice at the moment almost anything goes. Nevertheless, the industry manages to produce buildings from the drawings it prepares. Responsibility for poor drawings rest ultimately with the offices named on the drawings, although draughtsmen can do no better than their best and this depends largely on their training. Section 1 of BS 1192 goes on to state "... The recommendations are also intended as a basis for the instruction of architectural and building students and it is suggested that extensive use of it should be made by educational and training centres." Many draughtsmen, especially in consulting engineers' and manufacturers' drawing offices will have been trained in Engineering drawing using BS 308 (2).

In theory the situation seems no better than in practice. There are a number of widely published statements on the subject of drawings but they do not appear to be based on systematic studies, e.g. the R.I.B.A. Handbook (3) and Research and Development Handbook No. 6 by the Ministry of Public Building and Works (4). Furthermore the latest revision of BS 1192 (5) does not look as though any systematic research supported its preparation and it is safe to say that the standard is not widely known or applied.

The more serious efforts to co-ordinate information (including drawings) such as CBC (6) and CI/SfB (7) remain isolated struggles to impose theoretical solutions on a reluctant industry - there is, so far, little evidence of success. The most striking aspect of the theoretical scene is the total absence of serious published research into the nature and function of drawings. Weakness in theoretical understanding of the subject has led to weakness in teaching drawing and practitioners have to rely on transmitted "know-how" in practice. Thus prior to these studies a search of the technical literature about drawings revealed no other data whatsoever with which to compare results.

It is hard to see how the situation can be improved without concerted action to implement a single soundly-based Standard by all the governing and advisory bodies connected with the building industry.

3. Procedures and methods.

Accuracy, clarity, absence of repetition and economy of means are desirable not only for individual drawings, however, but for the set. It is in this that BS 1192, and indeed every textbook on draughtsmanship to be found in libraries and technical bookshops, is so inadequate. A set of production drawings, such as those studied here is the work of many different people, (perhaps up to a hundred!). How good they are individually may have very little bearing on how good the set of drawings is as a set.

The production of a good set of drawings is not the result of individual skill. It is more a matter of the management and control of a team to achieve a planned objective. At present in the building industry there is no satisfactory understanding of the planned objective - a complete set of production drawings - less still is there adequate management and control to achieve it. The revealed data in these studies and the structure of the sets of drawings were markedly influenced by the very different procedures used in the various drawing offices.

Until more comparative, objective studies are made, however, there are no firm grounds as yet for choosing any particular procedures. What is important is that for each project all the drawing offices concerned should adopt drawing procedures as a team and in advance, each co-ordinating their own preferences and practices with the other. This is already done for some projects but there appears to be a general need for still more precision in defining many key procedures, e.g. co-ordination drawings, checking drawings, the use of copy negatives, and so on, as well as a need, confirmed in these studies, for defining content groups and drawing up checklists for them.

Recommendations

No simple routine procedure, short of actual building, has been devised for a foolproof check that all drawings have been made. This is not surprising considering the varieties of briefing, design, contracting and construction methods in current use. In fact, until the contractors themselves are capable of determining in complete and precise detail what set of drawings is required for production purposes, there will always be uncertainty in this for design teams - sometimes far too much uncertainty. However, arising directly from this study has come recognition of the total set of drawings for the project, its structure of interdependent subsets, and the need for the Design Team to plan and co-ordinate the preparation of the set in advance. This is the best approach both to coordination and to reducing undertainty and incompleteness in the set.

Accordingly, a code of recommendations for Production Drawings has been drafted and these recommendations are set out as a procedural guide for Design Teams and are based on the need to adapt, extend and refine existing (and therefore viable and familiar) procedures rather than introduce some new and fundamentally different system to which most practitioners respond apathetically or even with hostility:

1. Design Team to plan the set of production drawings by the start of R.I.B.A. Plan of Work Stage E (1).

2. Planned set of production drawings to be scheduled with the following data for each drawing:-

   Office of origin, drawing number, last revision, full title, size, scale(s) and content group. Allocate blocks of numbers where exact number is still unknown.

3. Drawing schedules to be architects' drawings and themselves listed as first group of production drawings in set.

4. Set of production drawings to consist of sub-sets, one for each office making drawings.

5. Drawing numbers and titles to be unique for each drawing. Elaborate codes are only useful if understood, agreed and used

consistently by all.

6. All drawings to be standard A sizes (8), preferably A1. There is a need for a size larger than A1 where the size and shape of the building at the preferred scale demands it. One larger size (A0), Double Elephant, etc.) should be adopted by the Team but <u>only</u> for floor layouts, sections, elevations or site plans which are either too large for A1 or incapable of being sub-divided conveniently.

7. A detailed content checklist for each group of drawings to be prepared and issued.

8. Design Team initially to agree policy and procedures for drawing techniques, basic data, checking, cross-referencing, preferred scales and the use of copy negatives.

9. Review and updating of drawing schedules to be included at agreed stages in the programme.

10. These recommendations to be issued to all specialists, sub-contractors and others preparing drawings for the project.

Conclusion

These studies have demonstrated clearly that our drawings are not as effective as they should be. We cannot improve their effectiveness without wider understanding and deeper knowledge and this can only be obtained by research studies.

As a direct result of these studies our work is already improving in practice. This was our aim but these studies were literally only a beginning and there is still much more to know. At present we are making two further studies of production drawings (9). Another important study of production drawings is being made by the Building Research Station, the major central government agency for building research in Britain (10).

Production drawings are perhaps the easiest kind of drawings to study for their main function is clear. Design drawings in all their wide variety of purpose, however, may be of greater importance. They too must be studied although this will certainly prove very much more difficult to tackle. We feel our studies have indicated something of the nature of all drawing which will therefore help to ease that difficulty.

Acknowledgment

I would like to thank the Partners of George/Trew/Dunn for permission tp publish this paper.

Notes

1. ROYAL INSTITUTE OF BRITISH ARCHITECTS. Plan of Work for Design Team Operation. London, 1967.

2. BRITISH STANDARDS INSTITUTION. BS 308:1964, Engineering Drawing Practice, London 1964.

3. ROYAL INSTITUTE OF BRITISH ARCHITECTS. Handbook of Architectural Practice and Management, Part 3.410, London 1967.

4. MINISTRY OF PUBLIC BUILDING AND WORKS, R & D. Building Management Handbook No. 6 Programming and Progressing in the Design of Buildings, Section 16. London, H.M.S.O. 1969.

5. ALEXANDER, R. BS 1192:1969. Recommendations for building drawing practice: A detailed critique, the Architects Journal, London, 9 July 1969.

6. BINDSLEV, BJORN. CBC - Co-ordinated Building Communication, The Architects' Journal, London, 1st. April 1964.

7. RAY-JONES, A and McCANN, W. CI/SfB Project Manual. The Architectural Press, London 1971.

8. BRITISH STANDARDS INSTITUTION. BS 3429:1961 Sizes of Drawing Sheets. London, 1961.

9. Two studies are currently in progress; the first is the monitoring of all revisions to a set of drawings as they take place during construction; the second is a long term study of the application of the recommendations made here to a large hospital project.

10. The Building Research Station is currently studying the relevance of documents especially the content of drawings and the information search pattern generated. The results of a large sample analysis are due for publication during 1972.