

The planning and management of the Consulting Engineer's supervisory team at Kainji Dam

A. L. H. BAYLIS

Mr Baylis

The construction period at Kainji ran from 1964 to 1969, and the site organization proved sufficiently resilient to adapt to the changing conditions of those times. Although the site was not in the Eastern Region, the civil war there had indirect effects on the project. Nevertheless, the site organization survived, with slight adaptations, and the project continued. The impounding of the lake took place as scheduled and the power station was commissioned nine days ahead of schedule. It seems useful to extract from the Consulting Engineer's site organization basic principles which could be of value to engineers on other projects.

83. The Consulting Engineers located their main site office at the dam site because this was the centre of gravity of the construction. The Client, the Niger Dams Authority, occupied offices in Lagos, and so the Consulting Engineers opened a small office there in charge of the Joint Consultants' representative, and this office was linked to the Chief Resident Engineer's office at Kainji by telephone, radio and telex. Thus the Lagos office provided the necessary communications link with the Client.

84. Considerable emphasis was placed on the provision of educational, medical and recreational facilities during the construction period because of the remoteness of the site so that the families who lived at Kainji for up to five years could enjoy an orderly and contented way of life. This minimized discontent and resignations among the site staff, and kept the team a happy unit, assisting greatly in the successful and timely completion of the project.

Mr T. D. Kershaw, Engineering and Power Development Consultants Ltd

The first vital point made in the Paper is the necessity to plan ahead. I think this goes back to planning at the stage the contract documents are designed. It may be necessary to amend the Conditions of Contract to ensure that the engineer and the engineer's representative have the requisite tools of control to carry out their responsibilities. It may be that if supervision is to be minimal or on a spot check basis, allowances have to be made in the design and specification. Once a major project starts there is insufficient time to work out solutions to problems and detailed procedures to meet every eventuality. To this end the Manual of Procedures is invaluable, in that guidelines are already established and forms and schedules are illustrated which can be readily adapted to meet particular circumstances. A simple form can require several hours of senior engineers' time in drafting when time is at a premium.

86. The second point is the necessity for close liaison with the client. The Engineer's representative is frequently more in day to day contact with the client than his own head office. Relations with the client can become strained, and the engineer's representative must explain to the client why costs are rising, and why things are going wrong. The client, who has virtually given the consultant a cost plus assignment, has financial and political pressures on him and must be worried when costs rise and he has no way of directly controlling them. The engineer's representative should lead the joint consultant/contractor site team.

87. In consulting engineering one cannot always retain senior resident engineers on the staff. The ideal solution is to retain them and use them when necessary, but that is not always possible. Unless experience is ploughed back by the maintenance of a Manual of Site Procedures, reviewed and regularly revised, much valuable experience is lost.

88. On an overseas site power is normally delegated to the chief resident engineer or to the engineer's representative, and once this power has been delegated it is necessary to back the man on the site.

89. I agree about the importance of phasing through from the civil phase to the electrical and mechanical phase. Inevitably the civil works which precede the installation of electrical and mechanical plant will result in the establishment of an organization with a civil engineering bias. I think it is important that the civil engineer who starts the site organization should have as good an appreciation of the later requirements of electrical and mechanical construction as he must have of the civil design requirements.

90. I think more emphasis should be given to the effectiveness of planning and monitoring. All too frequently complex programmes are produced, and progress against such programmes is reported on in detail; but it is sometimes difficult to see what action is taken to meet the points raised by the planners. At Kainji the Co-ordination and Planning Engineer was given seniority equivalent to that of the Senior Resident Engineer, civil works, and the Senior Resident Engineer, electrical and mechanical, and as such had direct access to the Chief Resident Engineer. As a result, the Chief Resident Engineer was directly and promptly informed of serious programme difficulties and able to ensure that remedial action was taken as soon as possible. This did not mean that the co-ordination and planning occupied much of the Chief Resident Engineer's time, but it meant that points raised were not glossed over at progress meetings. The Co-ordination and Planning Engineer won the respect and attention of the senior site staff who made the fullest use of his services.

91. It is desirable once a week for the senior man on the site to ask himself, 'What has happened this week? Am I sure that head office is fully informed and fully understands this problem?' An informal report from the chief resident engineer to the project manager at head office has great value and can save many misunderstandings.

92. Attention must be paid to human problems if a site team is to be happy and effective. If there are to be married families—and this opens up a much wider market when recruiting—there must be married accommodation and schooling, medical and recreational facilities. The Author emphasizes that the client must be advised of the cost of the site supervisory team, and I think this means advising him of the cost of providing accommodation and facilities for married families. Housing could cost £3000–£4000 per family, and it is not always possible to use it later. The construction camp infrastructure, i.e. roads, water supply, generating capacity, recreational facilities and so on, will also cost more if provision is to be made for families. Air fares bills could be trebled if families accompany site staff. Schooling could cost up to £400 per head per annum, even if restricted to a maximum age of 12. The client must know his financial commitment before agreeing to married families being on site.

93. Kainji had a magnificent hospital with two operating theatres, three surgeons, a pathological laboratory, and so forth, with full nursing staff, but in the early days parents sometimes said, 'I want to fly my child home. I do not want to see a foreign doctor.' Later this lack of communication and confidence was overcome.

94. The organization at Kainji was successful, and the project used to illustrate the Author's philosophy was seen through to a successful conclusion in difficult circumstances. The management system is not the only one which will work, but I am sure the basic principles are sound and cover all main aspects of the problem.

Mr J. R. Gwyther, Binnie & Partners

I should like to compare the arrangements at Kainji with those at Mangla.¹ The main differences appear to be that Mangla, although larger with an average rate of earning of over £1 million per month, had a compact layout, a great deal of the activity being concentrated within 3 km². This made for easy communication and the organization was based on technical boundaries.

96. One main contractor at Mangla was responsible for all the civil work, the erection of mechanical and electrical equipment and the transportation of everything to the site. The Mangla project is in a country with a long tradition of irrigation works and technically trained staff were available locally—the main thing new to them was the pace of the work and updated techniques and equipment.

97. The holding together of a team at Kainji during a civil war was a magnificent achievement. Mangla was also involved in war, but nevertheless the project—with a great many additional works—was completed a year ahead of schedule.

98. On human relationships, there are difficulties when people of different cultures work together as a team. At Mangla a Pakistani of status second only to the Engineer's Representative was delegated to make sure that such difficulties were kept to a minimum. The Engineer's Representative also visited all parts of the works day and night in order to speak with the locally engaged staff in the field, and to get to know them and their problems. With a large and competent staff supervising all the technical aspects, the 'chief executive' could fulfil a useful role in the maintenance of good relationships among them.

99. Delegation of responsibility is essential for the best performance of any organization. Senior site staff are selected for their knowledge and ability and should be given as much freedom as practicable in exercising their functions. On large projects resident engineers respond better if the chief executives give them freedom to manage their own sections of projects.

100. Specialist staff on site should be given the opportunity to communicate directly with their opposite numbers in head office, differentiating between matters of fact and matters of opinion. Such communication should be channelled through the engineer's representative, who is expected to add his comments.

101. Nothing is more frustrating than the denial of freedom to make decisions within one's competence; censorship of observations of a strictly specialist nature may not receive adequate consideration from a chief executive.

102. Planning the work seems to have been largely the responsibility of the Engineer's Representative at Kainji. At Mangla the contractor set the pace in order to achieve the dates specified under the contract. The contractor's chief engineer at head office regularly updated the PERT network personally. It was appropriate for him to do so as he alone was aware of the resources available.

103. I commend the daily Works diary maintained at Kainji and signed by the Contractor and Engineer's Representative. I presume this was a requirement under the Contract. How and by whom was it compiled? In the Author's opinion, did it justify the necessary effort and diplomacy? It must be a remarkable factual account of events.

104. Inspection at Mangla was carried out by the locally engaged staff under a few specialist expatriate inspectors and engineers. The Chief Inspector at Kainji was responsible to the Engineer's Representative for missions in addition to his duties under a Resident Engineer. Would the Author elaborate on this role?

105. I understand that VIPs were conducted around the site by the Engineer's Representative, as the Client was not represented at site. It would be more appropriate for the client to exercise this function and in his own best interests to do so.

106. The client has a right to an estimate of the cost of supervision but it can vary considerably, depending on the circumstances. I do not believe a firm budget of all

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costs for supervision of construction can be prepared until all details including the performance of the contractor are known.

107. At Mangla the staff position was reviewed annually and this took account of the changing ability of locally employed staff with subsequent reductions in the more expensive expatriates. The cost of providing and maintaining the engineer's supervisory organization at Mangla was approximately 4.8% of the final cost of the contract of £155 million. Approximately half of this was accounted for by payroll costs and the other half by the cost of providing and maintaining offices, transport equipment and 'permanent' staff housing and facilities for expatriate staff. About 1% of the contract cost was in respect of payroll costs of head office staff engaged on direction and design concurrent with construction. The client provided permanent housing for the 600 Pakistani staff and their families, which is now occupied by the client. The expatriate staff housing and the houses and facilities provided by the contractor were handed over to the military authorities.

Mr G. R. Carr, formerly Civil Design Project Engineer, Balfour, Beatty & Co. Ltd

My remarks are made from the viewpoint of the design office. The Author rightly emphasizes the need for a 'constant flow of evidence that will answer the designer's questions'. This implies that the site engineers are in a position to foresee the type of information required by having an adequate understanding of the design philosophy. An understanding of the maintenance philosophy may also be required, for example, in the case of dam instrumentation. These philosophies should therefore be set out before the supervisory team starts work, or at least before construction of any particular component is started. This can probably best be done by means of design reports prepared by the design office in conjunction with the drawings. This was only partly accomplished at Kainji.

109. Of further assistance to this understanding at site of the designer's intentions is the inclusion among the site staff of engineers who have been involved in the design concept during the tender design stage.

110. The emphasis placed by the Author on the necessary quality of inspection and inspectors must be allied to the equally important requirement of providing a team of suitably qualified engineers. This team must be capable of integrating the inspection and control of construction with the interpretation, adaptation and general execution of the designer's intentions as a whole, at minimum cost within the contractual context.

111. Although visits to Kainji by design office staff took place regularly and on occasion design staff were seconded to site for specific purposes and limited duration, frequently design and specification amendments were necessary which had to be handled by telex or mail. In most cases the design changes involved required a high level of judgement by the site engineers of the physical conditions to be met, the study of trial solutions and explicit communication between site and head office.

112. The handling of such changes in co-ordination with head office must be anticipated on any large and remotely located job such as Kainji. Particularly important at Kainji was the inclusion on the Resident Engineer's staff of a senior engineering geologist and a senior soils engineer, the latter being experienced in fill dam design. As tends to be the case with embankments if they are to be built economically and effectively to suit the site conditions, the final design of the fill dams was largely determined at site and confirmed by head office.

113. Typical of design changes occurring during construction at Kainji were such aspects as the treatment of fault zones, redesign of the Saddle Dam to deal with a buried river channel, remedial prestressing of the rock upstand forming the control building foundation and modifications to the design of the main fill dam. The planning of the diversion arrangements in co-ordination with the Contractor and the Engineer's head office also required a high degree of engineering skill from the site staff. The role

of the site planning engineer in this and many other programming aspects was vitally important, and greatly aided the effective liaison established between site and head offices in regard to civil, electrical and mechanical aspects. This liaison contributed much to the completion of the project on time.

114. The provision of a rapid system of communication between site and respective head offices greatly assisted the task. The telex facilities to Lagos from head office became indispensable. However, urgent communication between Lagos and Kainji had to be covered mainly by radio-telephone and risked inaccurate relaying of information unless confirmed later in writing.

115. Although the extensive use of telex tended to impose 'instant decision' at both ends, and necessitated discipline in formulating brief messages, it diminished the feeling of remoteness of the project and gave untold assistance to its completion on time.

116. The need to prepare site reports on the construction before knowledgeable staff are dispersed towards the end of a job is a problem and unless early priority is placed on these tasks is difficult to overcome. The preparation of these reports and records is important if mistakes are not to be repeated, and if the owner requires a comprehensive history of the construction of his works. It is at least necessary for site engineers to keep clear notes of construction methods and occurrences, and for interim reports on particular features to be issued to head office as the work progresses. I think the preparation by site staff of a critical appraisal of the specification is particularly important.

117. About 5000 as-built and record drawings relating to civil works were issued by site at Kainji. The planning for these must be envisaged at the outset and they should be produced as each section of work is completed, in conjunction with the final measurement drawings processed by the quantity surveyors.

118. At Kainji there was a high degree of co-ordination and understanding established between the site staff and the design office. The project was also notable for the harmony of international co-operation between the joint consultants and the contractors involved.

Mr D. Cooper, Balfour, Beatty & Co. Ltd

It seems to me that little needs to be said about the engineering aspects of the supervision; most thought and planning consideration needs to be given to the general management and administration of the site team.

120. From this aspect there are great differences between the requirements of one job and those of another, stemming partly from the size of the job and partly from the location.

121. On one isolated job I once worked on a letter took three months to reach head office and it was another three months before a reply was received. The Resident Engineer was left in no doubt about who was responsible for the decisions, but it meant that he was very much on his own, and head office had to follow on as best it could.

122. While the work at Kainji was going on there must have been many changes in the staff. To what extent was the organization kept fairly rigid, and were people recruited to fill places in the organization, and to what extent did the organization itself evolve to take account of the particular talents of new recruits?

123. Did the Client have a representative on the site, and to what extent did his requirements dictate the way the job was organized in contrast to other jobs where his requirements might have been different?

124. What was the cost of supervision, leaving aside the welfare aspects, as a percentage of the overall cost of the project?

125. To what extent was the project responsible for giving an opportunity to

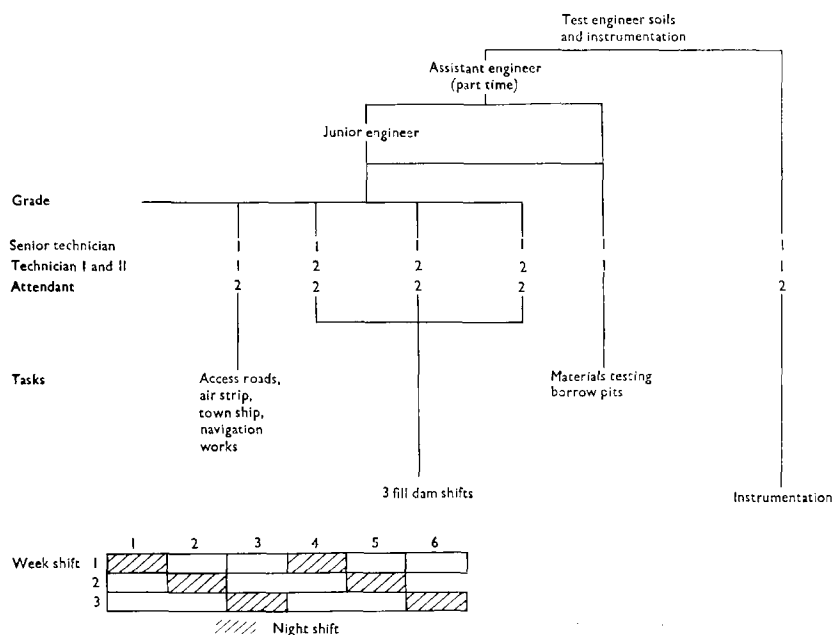


Fig. 6. Organization chart—soils section

African engineers, inspectors and other technicians to gain some useful experience, and to what extent might they later be able to benefit from this experience?

Mr J. Wrightman, Department of the Environment

From 1964 to 1966 I was test engineer soils at Kainji dam site.

127. With reference to § 3 I think there is an important factor involved in the making of this decision by the Engineer, and that is the tolerance in the design. For example, with a design which can be compromised when the specification is not fully complied with, and careful work must be done to achieve that specification, there is a need for intensive supervision and testing. However, if the design is not compromised when the specification is not fully complied with, and the design has wide tolerances, little supervision and testing is necessary. This is the difference between supervising the building of a 200 ft high steep-sided earth and rockfill dam using thin bands of variable residual soils for the core, culled from several square miles, and the building of a 20 ft high road bank of London clay taken from a nearby cutting. On the basis of the Engineer's specification Kainji was judged to require rigorous testing and supervision, and an attempt was made at site to base the soils testing organization, its deployment and its tasks on this premise.

128. I think the testing facilities at Kainji were at least as important as other facilities if not vital to the proper construction of the work. The testing organization is mentioned in Fig. 1, but where would it fit in Fig. 2?

129. Figure 6 shows the organization of the soil testing and fill dams section, approximately half of the work load only being concerned with testing on the dam itself. Table 6 shows the proficiency of the laboratory staff in the various tests.

130. On fill dams work often went on day and night with a break of 24 hours on

Sunday. Therefore the fill dams group was organized in three shifts, one shift on night work testing on the dam and two on the day shift. The organization was flexible and dependent on the Contractor's programme. The junior Engineer, a young Nigerian with elementary school education, carried a lot of responsibility, organizing his transport and teams on the dam, in the borrow pits, rearranging things when sickness left gaps, chasing results and updating the running plot of compliance test results. The five senior technicians, also with only elementary school education, were all required to organize their groups and could be relied on to work on their own even at night. Their average age was about 25.

131. The section organization at first envisaged was much smaller than the one found to be necessary because of the Contractor's decision to work at night and also to seek earthfill from areas not previously investigated. Although the onus was on the Contractor to demonstrate that such soils met the specification, it was thought prudent to check his work in the Engineer's laboratory. Another point which led to an increase in staff was the incidence of sickness, which was far greater than anticipated.

Mr W. R. Raingley, Sir Alexander Gibb & Partners

Everything on this Project seems to have been very successful, but I am sure that if one started it again some things would be done differently. What are the main things that the Author would approach in a different way?

Table 6. Proficiency of laboratory staff

Test	Number proficient			
	Technician II	Technician I	Senior Technician	Junior Technician
Moisture content	5	5	5	1
Index properties—standard	5	5	5	1
Index properties—one point		5	5	1
Particle size—coarse	5	5	5	1
Particle size—calculations for coarse		1	5	1
Particle size—fine grained			5	1
Particle size—calculations for fine grained			5	1
Proctor compaction	5	5	5	1
Proctor compaction—calculations		1	5	1
Permeability tests		1	3	1
CBR tests		5	5	1
Soil cement tests		5	5	1
Specific gravity			5	1
Consolidation test			3	
Triaxial test			3	1
Borrow pit—trial holes		2	3	1
Borrow pit—summary sheets				1
In situ density test	5	5	5	1
Rigging manometers for piezometers			1	
Placing piezometers		1	1	1
Readings, calculations and graphs			1	
Plotting test results, averages and r.m.s.			1	1

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133. What kind of specification was worked to in regard to the earthfill? Was the specification for the materials rigid and the onus placed on the Contractor to find the materials, or was a more flexible approach used whereby the design was amended and adjusted according to the materials that proved available?

134. Was the soils laboratory run and operated entirely by the Resident Engineer's staff, with perhaps a parallel organization run by the Contractor, or was it provided by the Contractor and its operations supervised by the Consulting Engineer's staff?

Dr P. R. Vaughan, Imperial College of Science and Technology, London

If the personal relationships between engineers on a site are satisfactory, I think that systems will work. If they are not, I doubt whether any organization will work satisfactorily. At Kainji the staff worked extremely well together and most problems could be solved without acrimony. Since the Engineer's staff was jointly Dutch and British this involved international co-operation, with staff of the two nationalities distributed among the various sections of the works, largely irrespective of the design responsibility.

136. On a site of this size common services such as laboratories which serve different sections of the organization require horizontal lines of communication. Particular attention is required to ensure that such services operate under proper control.

137. The written word is an excellent and necessary way of recording information but a poor way of communicating, particularly within one organization. Various regular internal meetings were held at Kainji, which went some way to avoid unnecessary paper work. The works diary was useful for recording matters of agreed fact, which might otherwise have required correspondence with the Contractor.

Mr L. I. Uncles, formerly Resident Engineer, Merz and McLellan, Niger Dams Project

At the end of the project was there a co-ordinating committee between the Client and the Engineer to decide what should be kept besides record drawings?

139. Was enough briefing given to wives before they went to Kainji? My experience is that most complaints are made by wives at the start of a tour and are a result of the new and strange environment. In the case of young children who accompanied parents, when they returned to the UK in many cases they were marking time because their education was at an advanced level.

140. Safety was obviously important. Did the engineers find that they had to be more vigilant because the contractors' standards were not perhaps as high as those in the UK, or was it because of the large numbers of Africans who were not used to this type of work?

Mr B. M. U. Bennell, Overseas Development Administration

I am interested in the arrangements that were made to hand over the installations to the Nigerian authorities. In many cases sophisticated testing facilities have been installed and subsequently have fallen into disuse. What arrangements were made to train local staff to continue observations, and are they being kept up to date and monitored by responsible authorities? Are the hospitals, schools and so forth being used by the Nigerians?

142. How many senior staff were employed at the peak of the operation? What is the order of the remuneration for engineers? What factor was applied on UK salaries to induce staff to go and work overseas and to stay for several tours?

143. What was the cost of the supervising organization as a percentage of the total cost of the project?

Mr J. E. Gray, MICE

What was the effect on management structure of having a joint consultancy between Balfour Beatty and Nedeco? There would be the advantage of providing a mutual

check, but against that a top-heavy structure (§ 25) because of the constant need for referring between the two organizations.

145. Further to §§ 42 and 75, what was the relative 'drop out' rate for inspectors of works and for the young engineers who were repatriated prematurely and what were the reasons?

146. At what level of decision would it be necessary to refer as far up the management as, say, to DCRE level? How far did delegation go as regards, say, (a) the type and quantity of transport needed by engineers, surveyors, and inspectors working in the resettlement team, (b) the means of providing a mobile laboratory for extended site investigation—by using a caravan or by infrequent shifts of equipment between cheap buildings, and (c) the best base or location from which to supervise extended works?

147. What improvements would be suggested to the messing and accommodation facilities for bachelors or men who left their families at home? Single rooms were provided near one of the clubs with no cooking facilities. A mess hall was provided but no staff. The staffing was left to *ad hoc* arrangements which broke down at one stage, throwing the bachelors on to the very welcome hospitality of Impregilo's mess. I suggest that either full facilities, including catering staff, should be laid on and charged for, or bachelors should be given houses with kitchens.

148. There were two matters which greatly increased the problems to be dealt with at Kainji. First, the resettlement scheme was a late addition to the Consultant's responsibilities. His part did not include the social aspects of resettlement, only the engineering aspects. It was a considerable addition, being spread over such an area, and costing the equivalent of many complete engineering projects. Does Mr Baylis still feel that it was best dealt with from the main site office?

149. The slaughter of Ibos who lived in Northern Nigeria occurred near the peak of construction, in September 1966. Many of them, including senior staff, were warned or protected, and were able to hide or escape. The result, as intended, was that all remaining Ibos in the North left, leaving a gap in many organizations. It said much for all concerned, especially the Contractor, that the job was able to continue.

150. The use of the word 'control' seems wrong with respect to people. 'Control' as a verb is applied to things, which react according to the laws of mechanics. 'Supervise' or 'direct' seems more appropriate concerning people. The use of the word control implies a fallacy—that, given suitable sanctions, people can be made to do someone else's wishes. It is the art of supervision to ensure that people take the course which best satisfies the needs of the job and, wherever practicable, find satisfaction in doing so.

Mr Kershaw

In round figures the total cost of the Kainji Development was £N88 million.* The total contract cost of the main works was £N47 million and the total contract cost of resettlement works was £N10 million.

152. Site staff salaries and expenses (including the cost of air travel of families, sea freight of heavy baggage and local leave, the ratio of site salaries to expenses being 7.5 to 6) for the combined main works and resettlement supervisory team were 2.7% of the total contract cost of these works.

153. The cost of provision and maintenance of housing, office accommodation, laboratories, transport, clubs and schools was 2.05% of the total contract cost of the works, the greater part of this cost being housing and transport.

154. Great care must be taken to compare like with like when such figures are considered, but there is remarkable similarity between the sum of the two figures given (4.71%) and that quoted by Mr Gwyther for the Mangla supervisory team.

155. On salary scales for senior staff of the supervisory team, salaries on appointment were in the region of home salary plus 50%, dependent on the specific duties of

* £N 0.85 $\simeq$ £1 $\frac{1}{2}$ sterling.

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the site appointment. Salaries were reviewed annually and adjusted for merit, increased responsibility and, to a limited degree, for rise in cost of living. Following the civil disturbances which affected cost of living and site conditions appreciably, salaries were increased by 15%.

Mr Baylis

Mr Kershaw emphasizes the need for close liaison with the client, both in relation to keeping him updated about the work and fully informed about costs. A client who is a government department or a para-statal body may be tied for political reasons to the seat of government which, as at Kainji, may be a long way from the site. The consulting engineers are thus placed in a quandary as to where to locate their representative's office: near the client or at site. If a primary duty of the engineer's representative is to lead the joint consultant/contractor team he must be stationed at site.

157. The comment made about the hours spent by senior engineers in drafting standard forms is more important than it may appear. At Kainji over five hundred standard forms were used, covering soil and concrete test results, accident reports, inventories of household furniture and so on. The time spent by senior staff in drafting these and possibly redrafting them in the light of experience is considerable and can be greatly reduced if prototypes are available in a manual of procedures.

158. The comparison between Kainji and Mangla made by **Mr Gwyther** is interesting. The electrical and mechanical erection at Kainji was carried out under separate contracts. Thus it was the co-ordination rather than the planning of the work for which the Engineer's Representative was responsible at Kainji.

159. Entries for the works diary were submitted by the contractors, and by area engineers and above on the Consultant's site staff. The latter were put in on standard forms and edited to ensure that events of contractual significance were included and not matters of opinion.

160. The special duties carried out by the Chief Inspector of Works at the request of the Chief Resident Engineer included interviewing applicants for work at site; examination of the temporary tairrace bridges when computation indicated that fatigue failures might be expected; reports on the access roads and other works completed under preliminary contracts and now out of their defects liability periods; examination of bridge and road failures on the public highway between Jebba and Mokwa, a vital road link to the dam site; a trial run between Apapa and site with the road/rail transporter; the planning of means to control large timbers and tree trunks that might float down the lake after impounding (in the event such tree trunks that came down were easily dealt with by gangs working under the Chief Inspector).

161. VIPs were conducted round the site by the Client, but because he had no senior representative at site and many visitors came to see the dam the Engineer's representative evolved a standard procedure for visitors—an explanatory address followed by a site tour—and this was adopted for all important visitors.

162. **Mr Carr** makes the good point that a significant advantage obtains if some of the senior engineers in the site team have been involved in the design concept before the commencement of the works. His remarks add weight to three basic principles, namely that the office of the Engineer's representative should be on site, the need for the best available communications between site and head office and regular visits to site by members of the design team. Visits from site to head office may also be beneficial. For the same reason it is advisable for newly-recruited engineers on the supervisory team to spend some time at head office before going on site in order to become acquainted with the design engineers and to study the general design philosophy.

163. **Mr Cooper** is correct in stating that the Paper was concerned with the planning and administration aspects of the project. Although there are great differences between the requirements of one job and another there are undoubtedly many common areas in the fields of planning and administration. Improvements on this side can and should be made on successive projects. Lessons learned on the one should be

used in planning the next. This covers the range of organization, reporting, records, public relations and site procedures. Flexibility of approach must be maintained to meet particular needs. The site structure at Kainji was flexible enough to withstand the stresses brought about by the civil war. Men were indeed recruited to fill specific posts. In time many gravitated into different positions to which they were suited by virtue of special talents or interests. The reorganization at the finishes stage illustrates this clearly and was effective and economical.

164. The project took vacation students from the universities of Nigeria, Lagos and Zaria. Some of these later joined the site staff as pupil engineers after graduation. Some became assistant engineers after their year's pupilage. Excluding students, thirty to forty Nigerian engineers and inspectors of work were employed by the Consultants, but the Ibos amongst them were unable to continue their service after September 1966. A number of those who remained and saw the project completed joined the operational staff at the dam, including the Deputy Superintendent and the Station Hydrologist. On the contracting side skilled tradesmen, plant drivers and technicians, probably numbering several hundred, emerged from the project as an indirect but positive benefit to Nigeria.

165. I am grateful to **Mr Wrightman** for his comments on the organization of the testing facilities at Kainji. The manual of duties and responsibilities referred to in the Paper evolved over a period of time. It was ultimately produced in booklet form and included all staff in the concrete and soils test laboratories as well as the other sections at site. For purposes of illustration I gave only extracts from it. The booklet on junior staff was paralleled by one on senior staff and both evolved into their final shape after 2½ years of construction.

166. In reply to **Mr Raingley** the Paper was written with the hindsight of the project. The methods and procedures described were developed to a large extent as the job progressed. To avoid a similar process of evolution on another project it would be advantageous to make use of a manual of procedures incorporating the experience at Kainji. The process of improving and streamlining the site management procedures should continue through each job.

167. The Paper was not concerned with the technical aspects of the work nor with the specifications, but a flexible approach to the designs of the earthfill dams was used. Certain aspects of design and specification were amended in view of known site conditions, and this involved close liaison between the Area Engineer Fill Dams and the design engineers at Head Office.

168. **Dr Vaughan** makes an important point about personal relationships between engineers at site. If the team is to work well it must be of harmonious composition. Good personal relationships must also exist between individual engineers at site and their opposite numbers at head office. A personality clash between two otherwise sound men can have unfortunate effects on the job, particularly in the closed community of most overseas construction camps.

169. The aim to reduce unnecessary paperwork is commendable but difficult to achieve on a large project. As **Dr Vaughan** shows the system of internal meetings at Kainji went some way in this direction, but perhaps not far enough. An enormous amount of superfluous paper had to be burned on completion of the project.

170. In reply to **Mr Uncles'** point about what should be left at the conclusion of the project, discussions took place between head office and site as to which documents should be preserved and which destroyed. Head office, as the Engineer, liaised with the Client in this connexion. Apart from the Client's requirements all files relating to technical matters, costs, reports, records and personnel, and a copy of the works diary, were despatched to head office.

171. The importance of briefing wives adequately before they came to site was appreciated early on. Attempts were made to do this by sending head office information on site conditions, living standards, social amenities and so on, but this met with only partial success because it is difficult to brief a young woman adequately about

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conditions in a foreign country if she has never before been overseas. Also, conditions changed drastically during and after the troubles of 1966.

172. Safety is important on all projects where a risk to life and limb exists. The Contractor's safety record at Kainji compares favourably with those for similar dams. The Contractors and the Consultants were very conscious of the need to impose strict safety regulations to keep the accident rate to a minimum.

173. In answer to **Mr Bennell's** question about training a localized operational staff, Canadian Technical Assistance financed initial training and operation. The Ontario Hydro Electric Corporation handled this and established training schools at site 18 months before commissioning, on a four-year training programme. The last Canadian left site in July 1971.

174. All the facilities at Kainji were handed over to the Client. The Consulting Engineer's senior staff at site numbered 128 at peak.

175. In answer to **Mr Gray**, engineers from the two sides of the joint consultants were integrated as far as possible at site. It was felt undesirable in the supervisory team to man all of one section of the works with Dutch men and another with British. As far as was practicable the nationalities were mixed.

176. The principle under which the bachelors' mess was organized was that of full catering facilities under a mess committee. This started well when the mess was full but got into difficulties largely through lack of numbers which resulted in the mess becoming less economical to its members. After the upsets of September 1966, a manageress undertook to look after the catering side. Towards the end of the project when houses became vacant bachelors were moved into what had formerly been family accommodation and the bachelors' mess became an extension of the hotel.

Reference

1. BINNE G. M. *et al.* Mangla. *Proc. Instn Civ. Engrs*, 1967, **38** (Nov.) 338-576.