The Royal Engineering College, Cooper's Hill (1871-1906) : a case study of state involvement in professional civil engineering education.

Cuddy, B P

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THE ROYAL INDIAN ENGINEERING COLLEGE, COOPER'S HILL, (1871-1906)

A case study of State involvement in professional civil engineering education.

Thesis submitted for the degree of Doctor of Philosophy in the Faculty of Education of London University, (Chelsea College, Centre for Science Education) 1980.

Brendan P. Cuddy.
Brief Introduction to Sources

The Royal Indian Engineering College, Cooper's Hill, is one of the most neglected Institutions in the History of English Education. This scholarly neglect of Cooper's Hill is all the more perplexing in view of the unique character of the institution, representing as it did the first case of State participation in professional civil engineering education in Britain. The question of its neglect by historians may be answered partly in terms of incomplete sources, and partly because the writing of histories of defunct institutions has always resembled a cottage industry.

In this study an attempt is made to remedy that neglect by examining in detail the case for State involvement in engineering education. The records of the College were transferred to the Public Works Department of the India Office in 1907 and consist mainly of correspondence which was made up into subject files from 1882. Altogether there are some 408 separate files in this series * but the other Public Works, Military, Accountant General and Surveyors records, as well as the Minutes of the Council of India and the Papers of individual Members of Council and Secretaries of State for India have proved invaluable. In consequence all India Office Records are prefixed with 1OR/ and the appropriate India Office Classification is used.

A second collection of College Records exist at Cooper's Hill (now Shoreditch College, Brunel University) and consists principally of photographs and other mementos of life at the College. These are housed in a special room in the College Library, but as they are not as yet classified, they are referred to as the Cooper's Hill Society Papers.

The location of all other sources is given when such sources are considered difficult to locate but, in general, Newspapers, Contemporary Periodicals, Parliamentary Papers, etc., are referred to only by their title, date and page numbers.

+ One of the College 'Old Boys', J.G.P. Cameron, produced "A short history of the Royal Indian Engineering College, Cooper's Hill" (Cooper's Hill Society) in 1960, amounting to 38 pages.

* "The Records of the East India College, Haileybury, and Other Institutions" (India Office) 1976, by Anthony Farrington, pp.135-153.

‡ For a useful guide to this classification see "Archives" - the Journal of the British Records Association, Volume IX, No.43, April 1970. "The India Office Records" by Joan C. Lancaster, Deputy Keeper of the Records.
Acknowledgements

I wish to record my indebtedness to Chelsea College for the opportunity for research which the College Postgraduate Studentship afforded to me, and most especially to my supervisor, Dr. Tony Mansell, for his unfailing wisdom, encouragement and guidance throughout the project.

Special thanks are also due to my family for their continued support and understanding during what must, of necessity, have been a prolonged intrusion into family life.

I shall always remain grateful to those who have put at my disposal the collections in their care. To the staff at the India Office, the Institution of Civil Engineers, and other record offices for their understanding help, and particularly to Mr. Haywood at Cooper's Hill (now Shoreditch College, Brunel University) for giving me the 'free run' of the Cooper's Hill Society Records, and for his permission to reproduce the photographs enclosed.

Finally, my warmest thanks to Mrs. Shirley Ryall for typing this thesis with such remarkable willingness and accuracy.
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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.C.E.</td>
<td>Institution of Civil Engineers.</td>
</tr>
<tr>
<td>I.M.E.</td>
<td>Institution of Mechanical Engineers.</td>
</tr>
<tr>
<td>P.P.</td>
<td>Parliamentary Papers.</td>
</tr>
<tr>
<td>Trans. I.C.E.</td>
<td>Transactions of the Institution of Civil Engineers.</td>
</tr>
<tr>
<td>R.I.E.C.</td>
<td>Royal Indian Engineering College.</td>
</tr>
</tbody>
</table>
CHAPTER 1

The Profession of Civil Engineering in Britain in the 19th Century

The Royal Indian Engineering College was established in 1871 for the purpose of supplying engineers for service in the Indian Public Works Department. Its establishment represented a triumph for progressive forces concerned with civil engineering education and it is significant that such forces were largely to be found outside the Institution of Civil Engineers, the professional body representing civil engineers in Britain. The College's foundation occurred during Gladstone's reforming Parliament of 1868-1874, whose other major educational innovation lay in the Education Bill of 1870. Those arguing for systematic, scientific forms of education for engineers found an ally in Gladstone's Secretary of State for India who was receptive to scientific ideas and eager to see them applied in the service of Britain's Imperial role. This thesis is devoted to an examination of the roots of the College, its years of existence and its ultimate eclipse but we shall begin by considering the nature of civil engineering education in Britain, as it was accepted by the Institution of Civil Engineers.

The Institution of Civil Engineers (I.C.E.) was established on the 2nd January 1818 at a meeting held at the Kendal Coffee House in Fleet Street, and attended by the eight founders, James Ashwell, Charles Collinge, Joshua Field, James Jones, John Thomas Lethbridge, Thomas Maudsley, William Maudsley and Henry Robinson Palmer.\(^1\)

In the course of an Address to the meeting, \(^2\) H.R. Palmer cogently argued the urgent necessity for a source of information or instruction for persons engaged in Civil Engineering and emphasised the great advantages to be derived from recorded experience and the interchange of knowledge bearing on the actual circumstances found in practice. In consequence the
founders described the object of association as "for facilitating the acquirement of professional knowledge and for promoting mechanical philosophy".3

The motivation for establishing the Institution came from young engineers not yet established in their careers who were predominantly engaged in the construction of machinery, and their use of the term "civil engineer" served principally as a distinction between "civil" and "military" engineering. These men were disenchanted with the then existing "Society of Engineers" 4 which had been founded on the 19th March 1771 and which included some of the most eminent men in the profession. The Society of Engineers originated in the occasional contacts of civil engineers who drew up the plans deposited with Canal Bills in the Houses of Parliament and the Courts of Justice, "each maintaining the propriety of his own designs without knowing much of each other".5 It was proposed by one engineer to John Smeaton, "that such a state of 'the profession', then crude and in its infancy, was improper; and that it would be well, if some sort of occasional meeting, in a friendly way, was to be held; where they might shake hands together, and be personally known to one another:— that thus the sharp edge of their minds might be rubbed off, as it were, by a closer communication of ideas no ways naturally hostile; might promote the true end of the public business upon which they should happen to meet in the course of their employment without jostling one another with rudeness too common in the worthy part of the advocates of the law, whose interest it might be to push them on too far." 6

From its commencement the Society of Engineers (also known as the "Smeatonians" or the "Engineers") became a highly exclusive club serving the needs of only the most distinguished members of the profession. The Society met periodically
"during the session of Parliament" and although the attendance of members tended to be erratic, it is nevertheless conspicuous that in 1782 Smeaton read a paper on "An Experimental Enquiry concerning the Natural Powers of Water and Wind" which yielded an intensive discussion.

In 1792 the Society was reconstituted and its sixty-five members divided into three classes. The first class for purely professional engineers (approximately fifteen in number) included William Jessop, John Rennie, James Watt and Robert Whitworth. The second and third class consisted of "honorary members" who were not professional engineers but "men of science and gentlemen of rank" interested in engineering and were classified mainly in terms of social status. Thus, Sir Joseph Banks and the Earl of Morton were members of the second class and William Forden and Jessie Ramsden in the third class.

There is little documentary evidence on what actually took place at the earlier meetings, but it is clear that from 1792 onwards the Society developed into a dining and social club rather than a learned society designed to further scientific and professional knowledge. During the first quarter of the nineteenth century its activities were limited to an Annual General Meeting and six dinners per year.

The growing exclusiveness of the Society and the corresponding growth in the range and diversity of engineering activities provided a considerable residue of engineers with no collective or corporate identity. The need to consolidate their professional authority and status, and to provide a forum for the exchange of views on practical and theoretical engineering problems were the reasons which prompted the octet at the Kendal Coffee House to form the Institution of Civil Engineers.

However, from 1818 to 1820 only four new members were added to the original eight and it became apparent that if the
Institution was to survive and prosper it needed the guidance and patronage of an engineer of the highest repute. An engineer then at the "summit of his profession", Thomas Telford, was invited to become President, by a resolution dated 23rd January 1820, which stated:10

"That in order to give effect to the principle of the Institution, and to render its advantages more general both to members and the country, it is expedient to extend its Provisions by the election of a President whose extensive practice as a Civil Engineer has gained him the first-rate celebrity; and that a respectful communication be made to Thomas Telford, Esq., Civil Engineer, to patronize this Institution by taking upon himself the Office of President".

A letter inviting Telford to become President was dated 3rd February 1820 and in it the members described the objects of the Institution as "to facilitate the acquirement of knowledge in engineering, to establish in it the respectibility which it merits, and to increase the indispensable public confidence" ... "and to preserve selectness in its members".

On the 21st March 1820 Telford accepted the invitation to become the first President of the Institution and in the course of his inaugural address he underlined the need for professionalism rather than a mere study association. He noted, "In foreign countries similar establishments are instituted by Government, and their members and proceedings are under its control; but here a different course being adopted, it becomes incumbent on each individual member to feel that the very existence and prosperity of the Institution depend in no small degree on his personal conduct and exertions; and that merely mentioning the circumstances will, I am convinced, be sufficient to command the best efforts of the present and future members, always keeping in mind that talents and respectability are preferable to numbers, and that from too easy and promiscuous admission, unavoidable, and not infrequently incurable, inconveniences perplex most societies".12
The impetus generated by Telford's Presidency soon became evident and the Institution grew steadily until, on the 3rd June 1828, it received a Charter of Incorporation under the Great Seal, by the title of "The Institution of Civil Engineers". According to the "Regulations" of the Institution, membership consisted essentially of four classes: Members, Corresponding Members, Honorary Members and Associates. Members were practising civil engineers while corresponding members were full members but "who reside without the limits of the three-penny post" (i.e. outside London). Associates were those "whose pursuits constitute branches of engineering, but who are not engineers by Profession", whereas honorary members were not civil engineers but distinguished persons in related occupations (limited to a maximum of 40). Applications for election to all classes had to be supported "by at least three members of the Institution who shall certify their personal knowledge of such candidate", and election consisted of a ballot at the ordinary meeting of the Institution at which three quarters of the ballot was needed in support of the applicant.

In 1838 the qualifications of members and associates were defined more precisely and the class of corresponding members merged with the ordinary members. A new class of "graduates" was introduced to enable young men in the course of their education as engineers to join, but the full corporate privileges they were given were soon withdrawn (see below) and the class, later, more accurately labelled as "students". The growth of membership in the thirty year period 1841-1870 can be seen from the following table (page 12). However as the term "civil engineer" was quite nebulous with no legal restriction on its use, it is interesting to compare the numbers returned in census years as civil engineers with the number of members of the I.C.E. The following figures were extracted from:
(a) the census occupational abstracts for each of the years mentioned, and
(b) from the Minutes of Proceedings of the I.C.E. for the same years.

### Table I

<table>
<thead>
<tr>
<th>Years</th>
<th>Hon. Members</th>
<th>Members</th>
<th>Associates</th>
<th>&quot;Graduates&quot;</th>
<th>TOTAL</th>
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<td>26</td>
<td>176</td>
<td>205</td>
<td>68</td>
<td>475</td>
</tr>
<tr>
<td>1842</td>
<td>35</td>
<td>181</td>
<td>241</td>
<td>68</td>
<td>525</td>
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<tr>
<td>1843</td>
<td>35</td>
<td>184</td>
<td>276</td>
<td>65</td>
<td>560</td>
</tr>
<tr>
<td>1844</td>
<td>35</td>
<td>177</td>
<td>285</td>
<td>55</td>
<td>552</td>
</tr>
<tr>
<td>1845</td>
<td>35</td>
<td>194</td>
<td>302</td>
<td>51</td>
<td>582</td>
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<td>35</td>
<td>214</td>
<td>321</td>
<td>40</td>
<td>610</td>
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<td>224</td>
<td>332</td>
<td>35</td>
<td>626</td>
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<td>32</td>
<td>664</td>
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<td>34</td>
<td>244</td>
<td>371</td>
<td>32</td>
<td>681</td>
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<td>1851</td>
<td>33</td>
<td>247</td>
<td>406</td>
<td>30</td>
<td>716</td>
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<td>1852</td>
<td>30</td>
<td>251</td>
<td>438</td>
<td>26</td>
<td>745</td>
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<tr>
<td>1853</td>
<td>30</td>
<td>259</td>
<td>441</td>
<td>20</td>
<td>750</td>
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<tr>
<td>1854</td>
<td>28</td>
<td>277</td>
<td>449</td>
<td>19</td>
<td>773</td>
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<td>27</td>
<td>286</td>
<td>458</td>
<td>16</td>
<td>787</td>
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<td>1856</td>
<td>26</td>
<td>289</td>
<td>466</td>
<td>16</td>
<td>797</td>
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<td>1857</td>
<td>26</td>
<td>306</td>
<td>489</td>
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<td>835</td>
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<td>498</td>
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<td>857</td>
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<td>1859</td>
<td>25</td>
<td>332</td>
<td>523</td>
<td>14</td>
<td>894</td>
</tr>
<tr>
<td>1860</td>
<td>24</td>
<td>355</td>
<td>537</td>
<td>14</td>
<td>930</td>
</tr>
<tr>
<td>1861</td>
<td>22</td>
<td>369</td>
<td>542</td>
<td>12</td>
<td>945</td>
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<td>1862</td>
<td>20</td>
<td>405</td>
<td>565</td>
<td>10</td>
<td>1,000</td>
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<tr>
<td>1863</td>
<td>18</td>
<td>426</td>
<td>587</td>
<td>9</td>
<td>1,040</td>
</tr>
<tr>
<td>1864</td>
<td>18</td>
<td>452</td>
<td>617</td>
<td>8</td>
<td>1,095</td>
</tr>
<tr>
<td>1865</td>
<td>20</td>
<td>487</td>
<td>688</td>
<td>8</td>
<td>1,203</td>
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<tr>
<td>1866</td>
<td>20</td>
<td>541</td>
<td>771</td>
<td>7</td>
<td>1,339</td>
</tr>
<tr>
<td>1867</td>
<td>18</td>
<td>589</td>
<td>826</td>
<td>&quot;Students&quot;</td>
<td>1,433</td>
</tr>
<tr>
<td>1868</td>
<td>16</td>
<td>637</td>
<td>896</td>
<td>123</td>
<td>1,672</td>
</tr>
<tr>
<td>1869</td>
<td>16</td>
<td>655</td>
<td>918</td>
<td>138</td>
<td>1,727</td>
</tr>
<tr>
<td>1870</td>
<td>16</td>
<td>699</td>
<td>988</td>
<td>173</td>
<td>1,876</td>
</tr>
</tbody>
</table>
Table II
Numbers of civil engineers in various years

<table>
<thead>
<tr>
<th>Years</th>
<th>Census</th>
<th>I.C.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1841</td>
<td>859</td>
<td>475</td>
</tr>
<tr>
<td>1851</td>
<td>2,577</td>
<td>716</td>
</tr>
<tr>
<td>1861</td>
<td>3,329</td>
<td>945</td>
</tr>
<tr>
<td>1871</td>
<td>5,234</td>
<td>1,989</td>
</tr>
</tbody>
</table>

Several important changes were made in the "Bye-Laws" and "Regulations" to keep the Institution in tune with the needs of the Profession generally; for example, in 1846 the duration of the Presidency was altered to a maximum of two years. Following Telford's death on the 2nd September 1834, James Walker occupied the Chair for a period of ten years, and although the Regulations required annual elections, there was an implied understanding that the appointment was a permanent one. Several members rejected this interpretation and argued that the Institution would lose much of its vitality if the appointment was regarded as permanent. In consequence, two Special General Meetings were held on the 6th and 27th January 1846 where it was resolved that the office of President could not be held for more than two consecutive years. At the same meetings the qualifications of candidates for admission were redefined and the corporate privileges of the class of "graduates" were withdrawn. It was also agreed that the class of "graduates" should become extinct, and, henceforth young engineers would be admitted as Associates. Indeed it was not until 1867 that a special class for "students" was introduced.

From its inception the Institution was concerned with the promotion and diffusion of scientific knowledge bearing on civil engineering. The first paper received by the Institution was presented by Joshua Field on the 27th April 1819, being one of a small group of papers on Canal Locks. Although the "Minutes of
Proceedings of the I.C.E. were not published until Volume 1 in 1837, abstracts of the earlier proceedings were published in the "Athereum". Moreover, a selection of Papers and Addresses, prior to 1842, were published in three volumes of "Transactions" in 1836, 1838 and 1842.

The "Minutes of Proceedings" contain most of the Papers presented to the Institution together with reports of researches and inquiries made by Committees of the I.C.E. This literature, together with their collection of published material on civil engineering, forms the basis of the Institution's claim to "facilitate the acquirement of professional knowledge and for promoting mechanical philosophy". In this context, the Institution's Library — developed from a bequest of Telford's private library and a grant of £2,000 — was unique in possessing the original reports and other documents relating to the work of the early masters of civil engineering. Indeed when a catalogue of the Library was first published in 1851, it contained 3,000 volumes and 1,500 tracts. Fifteen years later when a second edition was issued the numbers were 5,500 volumes and 3,200 tracts, and in 1873 it was ascertained by actual enumeration that the number of volumes was 10,443 including 320 volumes of tracts. The Library contained most English works and a great many foreign ones on engineering and related subjects so that the Institution could boast that any treatise an engineer may reasonably want for his professional work shall be found in the Institution.

The first twenty-five years of the Institution's existence were highly successful both in terms of increased recruitment and the general increase in the qualifications of members. However, the three great railway "booms" of 1825, 1836 and 1840 produced in their wake a new generation or class of engineer who found the growing exclusiveness of the Institution of Civil
Engineers just as obnoxious as the octet in the Kendal Coffee House had found the old Society of Engineers. This new generation of engineers were dissatisfied with the compound title of "Civil Engineer" - originally intended to embrace all classes of engineers who did not belong to the military service - and they became increasingly conscious of their own particular needs in regard to professional status.

Much controversy surrounds the establishment in 1847 of the Institution of Mechanical Engineers and the consequent division of the profession. This controversy is largely centred on the contention of Samuel Smiles ¹⁹, and reproduced in R.H. Parsons "History of the Institution of Mechanical Engineers 1847-1947", that the I.M.E. was established because the I.C.E. refused to admit George Stephenson to membership of the I.C.E., without him previously submitting an essay as testimony of his capacity as an engineer - which Stephenson refused to do. However, the accuracy of this assertion and the implied insult to the "Father of the Railways" remains in doubt and cannot be substantiated by documentary evidence in the archives of either Institution.

Nevertheless, once begun the process of division in the engineering profession continued throughout the nineteenth century. In 1860 the Institution of Naval Architects was established because the members felt that "the problems of iron ship construction and propulsion were not being adequately discussed and catered for by the Mechanicals" ²⁰. Moreover, the following table shows the year of formation of the various engineering Institutions established throughout the century.
Table III

<table>
<thead>
<tr>
<th>Year of formation</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1818</td>
<td>Institution of Civil Engineers</td>
</tr>
<tr>
<td>1847</td>
<td>Institution of Mechanical Engineers</td>
</tr>
<tr>
<td>1860</td>
<td>Institution of Naval Architects</td>
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<tr>
<td>1863</td>
<td>Institution of Gas Engineers</td>
</tr>
<tr>
<td>1866</td>
<td>Royal Aeronautical Society</td>
</tr>
<tr>
<td>1871</td>
<td>Institution of Electrical Engineers</td>
</tr>
<tr>
<td>1873</td>
<td>Institution of Municipal Engineers</td>
</tr>
<tr>
<td>1889</td>
<td>Institution of Marine Engineers</td>
</tr>
<tr>
<td>1889</td>
<td>Institution of Mining Engineers</td>
</tr>
<tr>
<td>1892</td>
<td>Institution of Mining and Metallurgy</td>
</tr>
<tr>
<td>1897</td>
<td>Institution of Heating and Ventilating Engineers</td>
</tr>
</tbody>
</table>

One effect of the initial division between the I.C.E. and the I.M.E. was the establishment of a hierarchical order in engineering Institutions with the I.C.E. claiming the premier position. The "Civils" claims to such status were jealously promoted and were based essentially on two assertions: firstly, it possessed a Royal Charter and, secondly, it claimed to represent all engineers who were "civilian", as opposed to military engineers (despite the formation of the other specialist bodies). Even as late as 1889 the civils argued, "in the first place it is earnestly desired that all bona fide professional civil engineers, whatever their rank or standing, should belong to this Institution. The Institution gladly recognises other societies representing separate branches of the profession such as the I.M.E. ... But it must be again pointed out that all these branches are comprehended in the general designation of "civil engineering" and the parent Institution which represents the general profession, is open freely to engineers in all branches". They further argued that "nothing can be more incorrect or in worse taste than for the civil building engineers to adopt an attitude of superiority towards their "mechanical brethren", to
their work and to mechanical science; this holds only so long as such mechanical engineers are a specialist type of civil engineer, in turn being all non-military engineers, or members of the I.C.E. rather than the I.M.E." 22

Indeed, the establishment of the I.M.E. in 1847 was, in some ways, a positive advantage to the I.C.E. Very few members of the new society could have become full members of the I.C.E.23, and in this context, it served to prevent a dilution of the qualifications for membership of the I.C.E. and hence to advance the superior position of the civils - which was firmly based on their Royal Charter. Moreover, when in 1867 the Society of Engineers petitioned Parliament for a Royal Charter of Incorporation, the civils immediately countered with their own petition, arguing that a Royal Charter should not be granted to any body purporting to be a "society of engineers", regardless of the actual wording of this designation, as it would lead to confusion and undermine the prestige conferred by their designatory letters M.I.C.E. The Board of Trade accepted this argument and refused the grant of a Charter to the Society of Engineers. 24

Although the premier status of the "civils" vis-a-vis other engineering groups is significant, it is also important to note, as "the Engineer" did in a leading article in 1867, that the I.C.E. prescribed no curriculum, held no examinations, granted no Diplomas and conferred no degrees. Nevertheless they had decided views on the nature of engineering education which were, broadly speaking, accepted by the profession in all its branches. Their views owed much to tradition and were, to be fair to engineers, subject to increasing challenge as the century progressed. We shall now turn to a consideration of the Institution's attitude to the education of engineers.
The Education and Training of Civil Engineers (1818-1870)

In 1827 when Thomas Tredgold defined engineering as "the art of directing the Great Sources of Power in Nature for the use and convenience of man", the concept of "engineer" was quite nebulous and consequently no formalized system of education or training for the profession of civil engineer existed. The Charter of the I.C.E. attempted a more exact definition and emphasised that civil engineers were engaged in the construction of roads, bridges, aqueducts, canals, docks, ports, harbours, moles, in the drainage of cities and towns, and in the construction and adaption of machinery. Even as late as 1886 the Council of the I.C.E. found it necessary to give an extremely broad definition of the classes of works upon which civil engineers were engaged. They consisted of: (a) works bearing on internal communications (e.g. roads, railways, canals, telegraphs, etc.); (b) works connected with the sea coast, harbours, piers, breakwaters, sea-walls, lighthouses, etc.; (c) works for facilitating communications across the seas, including naval architecture, iron shipbuilding, construction and laying of submarine cables; (d) works connected with reclamation, irrigation, and drainage of land; (e) works for cities and towns, e.g. sewerage, water supply, lighting, street improvements; (f) any large buildings in their "mechanical and scientific arrangements"; (g) mining and metallurgy "so far as they involve the application of mechanical science"; (h) design and construction of the "mechanical prime movers", e.g. steam-engines, water-wheels, other hydraulic motors, windmills, electric and other engines; (i) "the design, construction and adaption to practical use of machinery and mechanical appliances of all kinds; (j) design and manufacture of all large and important metallic structures, "including artillery and other large munitions of war".
With such a broadly conceived subject area it is not surprising that (especially in the early days of the Institution's existence) the function of Architect, Engineer, Mechanic and Surveyor were not completely distinct and indeed many practitioners styled themselves as any combination of these four.

In an analysis of 55 of the most distinguished civil engineers born before 1780, it was revealed that 18 went through a craft apprenticeship (33%), 4 were engineering pupils (7%), 9 worked in engineering or related fields (16%), 6 were University educated (11%), 8 were recruited from other professions (15%), 5 from commerce and/or business (9%), one farmer, one "jack of all trades", one spinner and two for which there was insufficient data (taken together, 9%). 29

A similar analysis of 64, 55 and 47 eminent engineers (with entries in the Dictionary of National Biography) born respectively between 1780-1809, 1818-1829 and 1830-1849, revealed the following percentages. 30

<table>
<thead>
<tr>
<th>Training or experience</th>
<th>1780-1809</th>
<th>1810-1829</th>
<th>1830-1849</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprenticeship</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Craft</td>
<td>17%</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>- Engineering/pupil</td>
<td>23%</td>
<td>46%</td>
<td>45%</td>
</tr>
<tr>
<td>- Graduate</td>
<td>6%</td>
<td>13%</td>
<td>19%</td>
</tr>
<tr>
<td>Apprenticeship in related field, e.g. Architecture</td>
<td>10%</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>Worked in engineering or related field</td>
<td>6%</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Military experience</td>
<td>8%</td>
<td>2%</td>
<td>-</td>
</tr>
<tr>
<td>Direct entry post university</td>
<td>8%</td>
<td>7%</td>
<td>17%</td>
</tr>
<tr>
<td>Other profession</td>
<td>19%</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>Other occupation, e.g. business/commerce</td>
<td>3%</td>
<td>9%</td>
<td>-</td>
</tr>
</tbody>
</table>

This table gives an indication of the importance of pupilage as the preparation for a civil engineering career in the first fifty years of the Institution's existence. Further, because
of the highly selective nature of the "survey" it could be argued that the numbers entering from University are over-represented in the table. 31

Although the founders of the I.C.E. expected that the Institution would recruit its members from the ranks of experienced civil engineers, they also envisaged that the I.C.E. would assist in promoting a more regularised systematic process for training civil engineers in the twin aspects of theoretical and practical knowledge. However, a fundamental problem common to all professions attempting to establish themselves in the first half of the nineteenth century was the lack of educational provision. An extremely rudimentary system of primary and secondary education, catering principally for the middle and upper classes, existed. Moreover, in the 1820's, professional studies had no place in the University. 32 Law was studied at the Inns of Court, Medicine at the London Hospitals and for the Clergy, no special training was thought necessary. 33 Instruction at University might be given related to the engineering profession but the Universities considered their functions to be concerned with the liberal education of a privileged class who might later follow a profession. 34

However, it is possible to detect two distinct "waves" of interest in academic engineering education. The first, which came with the period of political reforms in the 1830's, may be considered as a "quantum jump" into the realms of purely professional studies. In this period Kings College, Durham, and Kings College, London, 36 introduced departments of civil engineering and mining. University College, London, 37 established a Chair in civil engineering although the first incumbent, C.B. Vignoles, did not take up his appointment until 1841. At Cambridge Robert Willis, the Jacksonian Professor, introduced a course of lectures in 1837 on "Statics, Dynamics
and Mechanism, with their practical applications to manufacturing processes, to engineering, and to architecture", which formed the basis of a science degree. Moreover, a "College of Civil Engineers was launched at Gordon House, Kentish Town, about the year 1839, by a body of Noblemen and Gentlemen who intended it as a system of education for youths in lieu of the system of pupilage to engineers then the only method of bringing up a youth to the profession". Glasgow University introduced a Chair of Engineering in 1840, (which was subsequently occupied by Rankine in 1856), and the Queens Colleges in Ireland and Trinity College, Dublin, also introduced engineering departments in this period.

The Institution of Civil Engineers was clearly in a unique position to influence the method of educating and training civil engineers, but because it was composed essentially of practically trained men there was an inherent bias against theoretical education. Even Telford had made this explicit in a letter written in 1821 regarding additions to the I.C.E. library. Thus, "You will remind them (Swedish Engineers), to send me drawings and descriptions of works actually executed. We have no wish for learned discussion; Facts and practical operations are to compose our collections and we should leave project and theory to those who are disposed to create new systems".

By the middle of the century two broadly identifiable groups were evident within the I.C.E. On the one hand were those who favoured a formal academic education and, on the other hand, were those who favoured a practical training, and between the two were many who regarded theoretical education and practical training like oil and water, immiscible. From the beginning the "educationalists" had always been in the minority and indeed of the first fourteen Presidents of the I.C.E. only
four had a University education. However in attempting to placate the educationalists the Institution declared: "Much has at times been said respecting the establishment of a school of engineers, and many comparisons have been drawn betwixt the advantages possessed by this and other countries in this respect; but not for an instant to enter on the great question of the nature of a complete establishment under that name, it may with confidence be asserted that this Institution is in itself a School of Engineers; a school, not in the term where knowledge is forced upon the unwitting student, but one where the attentive student possesses remarkable opportunities to self-improvement and mutual intercourse".

The courses established in the "first wave" of interest in formal academic engineering education may be generally regarded as promoted externally to the I.C.E. However, the Institution became alarmed at the growth of such courses, and, in his Presidential Address in 1841, James Walker observed, "now certainly the number of engineers, or students for engineering is increasing. If we look at the number of students in the classes for civil engineering at the different Universities and Academies; the Universities of Edinburgh and Durham, Kings College, University College, and the College for Civil Engineers in London; we are led to ask - will this country find employment for all these? I freely confess that I doubt it".

The resistance of the Institution to the expansion of academic engineering education and its promotion of practical training resulted in a lack of subscriptions for places on formal academic courses. Clearly there was little point in potential recruits embarking on a course of University education (and their parents on the consequent expense) if the I.C.E. preferred applicants to have undertaken pupilage or apprenticeship. In 1840 the School of Civil Engineers had 26 students but by 1863
it had ceased to exist. Durham engineering classes collapsed soon after they opened. Engineering education lay dormant at Cambridge for some years. In 1852 Putney College experienced a financial collapse as students found difficulty in paying the fees of between £160 and £180 per annum.

The "second wave" of academic interest came in the late sixties when the debate between theoretical education and practical training was resumed with a renewed vigour. This debate was highlighted by the results of the Paris International Exhibition in the Spring of 1867 when Britain excelled in scarcely twelve out of ninety departments. Such a clear challenge to Britain's comparative industrial advantage, arriving as it did in the wake of the sterling crisis of 1866, shocked the British public. In a celebrated letter to the Schools Enquiry Commission (under the Chairmanship of Lord Taunton), one of the jurors at the Exhibition, Dr. Lyon Playfair, argued "the one cause of this inferiority upon which there was most unanimity is that France, Prussia, Austria, Belgium and Switzerland possess good systems of industrial education for the masters and managers of factories and workshops and that England possesses none". The jurors were further unanimous in condemning the overwhelming respect for practice and a lack of concern for science in British industry.

Within the I.C.E. itself, the problem received much attention, but as the Institution was predominantly composed of practically trained engineers, with a "built-in-bias" in favour of perpetuating that system, the "educationalists" had an enormous task in trying to promote a greater emphasis on theoretical education. Indeed in his Presidential Address in 1866, Sir John Fowler had agreed that theoretical education in England was not considered equal to that in France or Germany but "in practical branches we are admittedly superior".
went on to argue that no advance in the theoretical "ought to be obtained by any sacrifice whatever in our undoubtedly great practical knowledge". Nevertheless Fowler acknowledged the need for a British "Ecole Polytechnique" and many members were sympathetic to this; but the domination of the Institution by practically trained men ensured little practical support. Fowler held that the preparation and training for a civil engineer should include (a) general instruction or a liberal education; (b) special knowledge as a preparation for technical knowledge; (c) technical knowledge, and (d) preparation for conducting practical works. Indeed, because of the I.C.E.'s insistence on practical training the Crystal Palace School of Practical Engineering was established in 1872 "to prepare students, by systematic practical instruction for professional articles, so that on entering an engineers office or works, the pupil may at once be useful to his principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession". In 1868 the I.C.E. undertook "an inquiry into the nature and status of engineering education in England and in other countries", which was published two years later. This inquiry noted that there was in England "no public provision for engineering education. Every candidate for the profession must get his technical, like his general education, as best he can; and this necessity has led to conditions of education peculiarly and essentially practical, such being the most direct and expeditions mode of getting into the way of practical employment". Further, "the education of an Engineer is, in fact, effected by a process analogous to that followed generally in trades, namely by a simple course of apprenticeship, usually with a premium, to a practising engineer; during which the pupil is supposed, by
taking part in the ordinary business routine, to become gradually familiar with the practical duties of the profession, so as at last to acquire competency to perform them alone, or, at least, after some further practical experience in a subordinate capacity." The reporters also noted that "it is not the custom in England to consider theoretical knowledge as absolutely essential" whereas "the practical education in England is perhaps the most perfect possible if the opportunities obtained during the pupilage are ample, and the pupil properly avails himself of them".

Nevertheless, the report recognised a series of institutions providing instruction "bearing on the profession of engineering", viz. Kings College, London; University College, London; The Royal School of Mines, London; The Royal School of Naval Architecture, London; the University of Edinburgh; University of Glasgow; Trinity College, Dublin; Royal College of Science, Dublin; Queens College, Cork; Owens College, Manchester; and the Royal Agricultural College, Cirencester, which gave some instruction relevant to the "constructive operations of agriculture" coming within the engineering field.

Against this, the continental system, epitomized by the French, provided a remarkable contrast. In France there were two divisions in the Government Corps of Engineers, viz. the Ingenieurs des Mines (which had the highest rank and were employed chiefly on mining operations and allied works) and the Ingenieurs des Ponts et Chaussees (which undertook the general public constructive works). There also existed a large body of civil engineers independent of the Government, with no official status who undertook private individual enterprises. For all three types of engineer the reporters observed, that practical training by apprenticeship was unknown; the education began at the other end, namely, by the compulsory acquirement of a high degree of
theoretical knowledge, under the direction, and generally at the expense, of the Government.

"Thus, while the English Engineer is launched in his profession with the qualification of a considerable practical experience, but with perhaps little or no theoretical knowledge, the foreign one begins with a thorough foundation of principles, but with a limited course of practice; a deficiency, however, which tends to correct itself with time." 52

In France the Government Engineers had first to pass a rigorous entrance examination (open to public competition) to a large general scientific establishment, the Ecole Polytechnique, where the education was purely scientific and theoretical, and from its students were taken not only the recruits for the Government Corps of Civil Engineers but also the scientific departments of the army and navy.

"After a two years course in the Ecole Polytechnique, such young men as are candidates for Government employment as Engineers are drafted off, also by strict examinations, into two special schools for the two departments respectively, namely, The Ecole des Mines and The Ecole des Ponts et Chaussees, in each of which the studies last three years. During the five years thus spent, the theoretical education given to the engineer is very complete, every branch of science bearing on his profession being taught him, and his proficiency being tested by the strictest examination at the end of the term. On passing the final examination, the pupil enters the corps he is destined for, and begins at once his official duty in the lowest grade." 53

Lest the impression be given that the practical side was totally ignored in France the reporters observed that lectures, descriptions and exercises were given very fully on practical matters, and added that the pupils were sent for a considerable
portion of the three years on "Missions" to various public works in practical execution under the department they were to be attached to.

For those civil engineers intending to take up private practice, education was given in the Ecole Centrale des Arts et Manufactures, which also had a strict entrance examination, for a course of study lasting three years. In the first year the instruction was theoretical only; in the second and third years theoretical and practical instruction were combined. The instruction here was more general so as to fit the engineers for the variety of work that they would be required to undertake but at the end of the three-year course a diploma was given to those who passed the highest examination, viz. the "Diploma of Ingenieur des Arts et Manufactures", (and a lower certificate of capacity to those who had simply satisfied the important points).

From the I.C.E.'s perspective the notion that "practical men are wanted, not mere theorists", held that any deficiency in theoretical or scientific attainments were clearly "outweighed by the proficiency in practical work". Consequently the route to employment as a civil engineer was through the office or workshop of a practising civil engineer. However, this system had three fundamental weaknesses. Firstly, the lack of any formal academic entry requirements left many pupils ill equipped to become competent engineers. Thus, Professor Fleeming Jenkyn in his inaugural address as Professor of Engineering at Edinburgh University noted, "from personal experience I can declare that most pupils are so ignorant of algebra that they are not only incapable of working out a result for themselves but actually cannot apply the simple formulae which are given in engineers pocket books. The calculation of the solid contents of a wall is often beyond their powers."
Their arithmetic is very shaky and a knowledge of physics, chemistry, geology or the higher mathematics is wonderfully rare. Secondly, the lack of adequate supervision of pupils resulted in theoretical knowledge being acquired in a most haphazard and unsystematic fashion. In this context an editorial in "Engineering" in 1866 noted "as it is the intending engineer may come from school, filled with French conjugations and English History, to be landed in an engineer's back-office to trace drawings, copy specifications, and smoke cigars for three or four years without having hardly so much as a word to illuminate the darkness before him". Thirdly, the high fees payable by students restricted the civil engineering profession to those of a comparatively high social class. Indeed Fleeming Jenkyn also argued that "the ordinary pupil is a sort of nuisance in an office, only tolerated in consideration of the fee which accompanies him". He further noted, "Young Englishman and their parents crowd the doors of the offices and workshops, offering premiums of £300 to £500 for the mere permission to pass three years unheeded inside the magic gates, which must be passed to gain entrance to the profession".

The payment of such high fees provides a rebuttal to the common assumption that the majority of Victorian civil engineers were either self-made men or that they rose from relatively humble origins. This illusion owes much to the writings of Samuel Smiles, who argued in his "Industrial Biography" that "the great inventor is one who has walked forth upon the Industrial World not from Universities, but from hovels; not as clad in silks and decked with honours, but as clad in fustian and grimed with soot and oil". Similarly, in "Self-Help" he argued that "early encounter with difficulty and adverse circumstances was the necessary and indispensible condition of success".

In a comparison of the cost of entering several English
professions in 1857, H.B. Thompson put the cost of entry into civil engineering at not less than £1,000. However, for pupils already in possession of a formal academic engineering education there existed additional handicaps. Thus employers tended to regard such potential pupils with apprehension, as upstarts, or, as a threat to the established order; in consequence, frequent examples exist of employers choosing unqualified over graduate pupils, because the latter had the additional task of unlearning what they had been taught. So, from the pupils' perspective there was little incentive to acquire a scientific basis for professional study, if employers were generally reluctant to engage such pupils. Moreover, it was extremely rare for employers to reduce fees, or the period of pupilage, for those in possession of a theoretical engineering education.

Although it is necessary to exercise extreme caution when dealing with such a nebulous concept as "social status", it may nevertheless be asserted that recruitment to the civil engineering profession was largely from the middle and upper social strata of society. McFarlane's analysis of the social class background of the engineers in his D.N.B. survey is shown in Table V.

Table V

<table>
<thead>
<tr>
<th>Social Strata</th>
<th>Born before 1780</th>
<th>1780-1809</th>
<th>1810-1829</th>
<th>1830-1849</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (Nobility, Gentry ..)</td>
<td>16%</td>
<td>31%</td>
<td>33%</td>
<td>34%</td>
</tr>
<tr>
<td>II (Professions ..)</td>
<td>33%</td>
<td>42%</td>
<td>49%</td>
<td>53%</td>
</tr>
<tr>
<td>III (Artisans ..)</td>
<td>46%</td>
<td>21%</td>
<td>9%</td>
<td>11%</td>
</tr>
<tr>
<td>No information</td>
<td>5%</td>
<td>6%</td>
<td>9%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Undoubtedly many of the "Greats" in Victorian civil engineering came from humble origins but once established in their careers they became highly esteemed and this esteem
permeated the rest of the profession. For the bulk of recruits however, entry to the profession was expensive both in terms of time and money invested, but the rewards lay in high remuneration and social status. The incomes of practising civil engineers varied considerably between the eminent "consultants" at one extreme, and those not yet established in their careers at the other. In 1857 "The Engineer" noted that men entering mid-career, between the ages of 28 and 35 who were not consultants, but worked in a full-time capacity either in a railway company, engineering firm or in some other type of work, typically commanded 500 to 800 pounds per year. Equally, the same journal observed in an editorial in 1865 that "an engineer, in these times, commands an amount of confidence hardly less than that accorded to a first-class General of old. If he need one million in money or ten, he gets it ... and none will contradict us that the engineer of established reputation rules nowadays with a mighty influence. There are those who would buy him at any price, and bid for him to his face, if they dared". Similarly, T.H.S. Escott argued that "at the head of all the new professions must be placed that of civil engineer".

Conclusions

The debates about engineering education within the I.C.E. led to little action to initiate new approaches to training, in spite of the evidence gathered from France and elsewhere of the importance of theoretical studies. The in-built resistance to change from men who had come up themselves through the pupilage system, and, one may fairly assume, the good remuneration to be had from taking pupils, militated against innovation. The Institution was also curiously reluctant to define codes of practice or to set up qualifying examinations. This was in contrast to the medical profession which had begun such tests
in the 1850's, and indeed it was not until 1897 that the Institution introduced examinations regulating entry to the profession.

Whilst ad hoc systems of training seemed to serve home needs, at least until the advent of Continental threats to British Industrial supremacy, the needs of Empire were being largely met by military engineers. As we shall see in the next Chapter, by the 1860's the military supply was proving inadequate for Indian needs, and attempts to use the civilian supply were revealing the grave inadequacies of the system.
CHAPTER I

Footnotes.


Equally the location of the first meeting is sometimes stated to be the "Kings Head Tavern in Cheapside", however, as Dr. Tudsbery compiled his historical sketch from the minutes and records of the original meeting and states the location to have been the Kendal Coffee House, this is now the accepted version.


4. This Society still exists today. For a general history see A.W. Skempton "The Smeatonians Duo Centenary, Notes on the Society of Civil Engineers 1771-1971" (London Soc. of Civil Engineers, 1971).

5. "Reports of the late Mr. John Smeaton, F.R.S., made on various occasions in the course of his employment as an engineer". Printed for a Select Committee of Civil Engineers by S. Brooke, 1797, p.VI.

6. Ibid.

7. For example, at the meeting held on the 24th April 1778, only two members attended and the Chairman recorded:

"Two melancholy members of this Civil Society met.
Mr. Pinchbeck in the Chair,
Mr. Whitworth - very near,
At ten being clear
And full of fear,
That no more members would appear
Both of them, each of them and all of them unanimously resolved to postpone the Meeting of this Society ..."

"Society of Engineers Minutes and Accounts 1771-1807 (not paginated)."
8. This reconstruction followed a dispute between John Smeaton and Joseph Nicholls in which Smeaton had condemned Nicholls' plans for a harbour at Bristol and Nicholls replied by casting aspersions on Smeaton's professional integrity. In Smeaton's Reports this is entered as "some untoward circumstances in the behaviour of one of the gentlemen towards Mr. Smeaton".

9. Telford's biographer Rolt (op. cit. footnote 1) notes that the Society developed into "an exclusive and purely social club", p.19.


11. This letter signed by the members, and Telford's formal reply dated 16th March 1820 can be seen in the Library of the I.C.E.


14. The class of "graduates" was to contain "those who, either as pupils or assistants to engineers are qualifying themselves for the practice of the profession, and are attaining to that degree of experience and knowledge which in the opinion of at least ten of the general body, with the concurrence of the Council, will entitle them to be enrolled in the class of Members", "Min. Proc. I.C.E." Vol.I (1837-41) 1838, p.2. Hence the term did not mean holders of University degrees but rather men who would gradually become full members of the I.C.E.

15. Compiled from the annual Min. Proc. I.C.E. and the membership Department's records.

16. "Min. Proc. I.C.E." Vol.V, p.7. At these meetings the inequity of the voting rights of "graduates" or "pupils" was discussed and it was decided that they should be prohibited from voting at the elections of the Council and officers, or from taking any active part in the direction and control of the Institution.

17. Subsequently, a MS Catalogue of the Library was prepared in three thick folio volumes devoted to Authors and one volume to Subjects. See the Report of the Council for 1886 "Min. Proc. I.C.E." Vol.LXXXVI, pp.172-174. Additions to the Library, by presentation and purchase, were normally published in the Annual Reports. In fact, at the time of election to membership, new members were expected to contribute to the Library "an original communication, drawing, plan or model of engineering interest, or some scientific work ... within the space of 12 months from the date of their election". However, comparatively few members fulfilled this promise. See for example "Min. Proc. I.C.E." Vol.V, p.6.
18. These engineers were principally engaged in the mechanical applications of engineering, e.g. in locomotive works, engine manufacturing or in machine tool factories. Consequently they viewed "civil engineering" as concerned with works of a static nature, e.g. roads, tunnels, harbours, etc. ... whereas their speciality was centred upon "mechanism". See R.H. Parsons "History of the Institution of Mechanical Engineers 1847-1947" (I.M.E. 1947) pp.1-2.


22. Ibid pp.27-28. According to the President, George Barclay Bruce, the other specialist bodies were merely "helping to do in sections, what it is committed to this Institution to have regard to and care for a whole". "Min. Proc. I.C.E." Vol.XCI (1888) Presidential Address, pp.1-35.

23. The qualifications for full membership of the I.C.E. were considerably higher than for the I.M.E. Indeed in 1860 "The Engineer" distinguished between the two Institutions declaring the I.M.E. to be a "commercial" institution and the I.C.E. a "professional" one.


26. Tredgold conceived of the engineer as "a mediator between the philosopher and working mechanic, and like an interpreter between two foreigners he must understand the language of both". Thus he applies to concrete problems in the everyday world the results of abstract study. For a reprint of Tredgold's definition see "Min. Proc. I.C.E." Vol.XXVII, pp.181-183.

27. "Trans I.C.E." (1836) "Charter of Incorporation" 3 June 1828, (pp.XXXVIII-XLI).
28. "Min. "roc. I.C.E." Vol. LXXXVI, pp.165-166. The Council further stated that "this is a comprehensive but by no means complete catalogue, and if an estimate is attempted to be formed of the work done under it during the last century, and of the effect this work has had on the development of trade and commerce, on finance, on government or industry ... it must be admitted that the professional of civil engineer has become a truly great power", p.166.

29. Bruce McFarlane (op. cit. footnote 20, p.61).

30. Ibid - Extracted from Table 13, p.61. Because of the unrepresentative nature of the "sample", great caution is needed before generalisations can be made based upon these percentages. However, the important point made by McFarlane is that a significant number of the most distinguished engineers entered through pupilage of some kind.

31. Between 1870 and 1906, 6.5% approximately of entrants to the I.C.E. (full membership) were in possession of a University degree at the time of nomination for Membership. Plainly, it could be argued that a higher percentage of the more distinguished members would have had a degree.

32. J.E.Gerstl and S.P.Hutton "Engineers: The Anatomy of a Profession" (Tavistock Publications, 1966) state that the oldest engineering college in Britain is "Anderson's College, Glasgow, which was founded in 1797 for artisans". This College later became the Royal Technical College and is now the University of Strathclyde. One of its most famous members was George Birkbeck. Similarly, T.J.N.Hilkin "Engineering at Cambridge" (1967) noted that scientific instruction on the mechanical properties of air, gases and other elastic fluids was given at Cambridge in the form of public lectures on hydrostatics and pneumaties as early as 1707. See also "Civil Engineering, the University Contribution" edited by Peter C.G. Isaac (Oriel Press 1970).

33. Although entrants to the Clergy were predominantly University educated, the subjects studied at University were not necessarily directly related to Holy Orders.

34. The outcome of debates on "Utility" in education, such as that between Locke and Newman, with the latter arguing that "intellectual culture is its own and, for what has its end in itself, has its use in itself also", was that Universities espoused the cause of a "good liberal education", and subjects with manifestly practical applications were treated with disfavour. See "The Idea of a University" by John Henry Cardinal Newman, first published in 1852. (Rinehart Press, 1960) p.122.


39. "Transactions of the Society of Engineers" (1930, pp.107-109) entitled "Putney College for Civil Engineers". In fact following an outbreak of Scarlet Fever at Gordon House, Kentish Town, the College was removed to Putney in 1841. For a Syllabus see pp.110-114.

40. H. G. Taylor "The Education of Engineers" (London, G. Bell & Sons, 1917) p.2. At Trinity College, Dublin, Sir John MacNeill was appointed Professor of Civil Engineering in 1842 and by 1870, 279 Licences to practical engineering had been issued. See infra. Ch. p.

41. L. T. C. Rolt "Thomas Telford" (op. cit. footnote 1, p.91) (Telford's italics).

42. The following is a list of the first fourteen Presidents of the I.C.E. to 1870. Those marked with an asterisk had been to University for at least one term: it is noteworthy that all four attended Scottish Universities -

1820-34 Thomas Telford
1835-45 James Walker * (Glasgow)
1845-48 Sir John Rennie
1848-50 Joshua Field
1850-52 Sir William Cubbitt
1852-54 James Meadows Rendel
1854-56 James Simpson
1856-58 Robert Stephenson * (Edinburgh)
1858-60 Joseph Locke
1860-62 George P. Bidder * (Edinburgh)
1862-64 John Hawkshaw
1864-66 John R. McClean * (Glasgow)
1866-68 John Fowler
1868-70 Charles Hutton Gregory.

43. Report of 1838, "School of Engineers", "Min. Proc. I.C.E." Vol.I (1837-1841) p.4. The theory was that the rising generation of engineers would communicate with each other, and receive instruction from the oracles of the profession, and acquire knowledge "which conversation alone can bring". This goal was not realised in any meaningful sense until March 1882 when the I.C.E. arranged a series of lectures by men of eminence to other members of the profession.


51. Ibid p.3.

52. Ibid p.XI.

53. Ibid p.XII.

54. "A Lecture on the Education of Civil and Mechanical Engineers in Great Britain and Abroad"; being a public Inaugural Address delivered in the University of Edinburgh, on Tuesday, 3rd November 1868. By Professor Fleeming Jenkyn, M.I.C.E., F.R.S., Edinburgh 1868. For extracts see Appendix B to the 1870 Report (Footnote 50).


57. Ibid.


62. B. McFarlane, (op. cit. footnote 20) p.60. The occupational classification used by McFarlane was based upon the father's occupation, position or rank, which were given as follows:

   I Nobility, gentry, generals, doctors, Bishops, vicars, rectors, professors, consuls, bankers, magistrates ...

   II Architects, surveyors, engineers, artists, landscape gardeners, merchants, solicitors, musicians, actors, curates, chemists, accountants, bailiffs, hotelliers, estate agents, farmers, writers, manufacturers, managers ...

   III Builders, joiners, masons, carpenters, porters, farm hands, tailors, shepherds and those described as of humble or poor origin ...


64. "The Engineer" Vol.19, 24 March 1865, p.185. This compares with some twenty years earlier "when Brindley, the canal engineer, was still reckoned a sort of superior ditch-digger, and George Stephenson a sort of superior engine-driver".

.../
64. ... continued ...


"India", Corelli Barnett has written, "was like a colossal mansion standing in the middle of a vast but ill-cultivated estate: it conferred prestige, it made the owners feel grand, and, by the cost of its upkeep, threatened them with ruin". 1 If we extend this metaphor a little further we see, cast in the roles of gardeners and estate keepers, the employees of the Indian Public Works Department (I.P.W.D.). Their tasks were to irrigate, to build bridges, roads, railways and ports: to spread the benefits of Western technology over the face of the sub-continent.

This chapter will focus attention on the I.P.W.D. 2 from about mid-century to 1870, and analyse the methods of recruitment to that Department from both Indian and British sources. Prior to 1850 recruitment to the I.P.W.D. tended to be from one source only and it is of major importance to understand the competence of that source for undertaking large scale public works, as well as its capacity for expansion. From this perspective then, it is possible to examine the growth in total expenditure on public works in India, and the avenues of supply utilised in meeting the increased demand for engineers.

At mid-century the I.P.W.D. was part of the Indian War (or Military) Department and was controlled by the 'Military Board' which was constituted to manage the different financial departments of the Army - of which the construction and maintenance of military buildings was one. The Military Board usually consisted of four or five members who were the heads respectively of the departments over which the Board presided, 3 but who had no control, other than in their capacity as members over their own branches of the service. However, the Board was rather
inaffective when it came to proposals for capital expenditure on public works because the Chief Engineer was liable to be overruled on any engineering matter by the united opinions of the other members. Equally, as the Board was basically established to audit and check expenditure its traditions referred to economy and retrenchment rather than expansion. Hence the department dignified by the title "public works" was essentially engaged in the conservancy of Government buildings, military and civil, scattered over the country: works that were "public" only in the sense of not being "private". Similarly the various roads constructed were regarded intrinsically as of military or strategic importance.4

Two notable exceptions to this schema existed in (a) the Ganges Canal and (b) the Trunk Road from Calcutta to the North-West, and as both were projected in 1842 it could be argued that they represent the first commitment on behalf of the State to construct "public works" in the proper sense, for the improvement of India. However it soon became evident that such cases of reproductive expenditure were not consistent with the principles of the Military Board and in 1854 control of public works was removed from the Board and a separate department of the Government was established for their conduct.

From the time of the establishment of the I.P.W.D. as a separate entity, the annual expenditure rapidly increased 5 so that in the ten year period from 1861-1870 the expenditure rose from approximately £3½ million to £6½ million. The following table shows the expenditure by Government on public works in India, according to the principal classifications.
TABLE VI

<table>
<thead>
<tr>
<th>Years ended</th>
<th>Military</th>
<th>Civil Buildings</th>
<th>Public Improvements</th>
<th>Establishments, Plants, Tools, etc.</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>1861</td>
<td>900,689</td>
<td>390,717</td>
<td>1,417,641</td>
<td>662,307</td>
<td>3,371,354</td>
</tr>
<tr>
<td>1862</td>
<td>537,623</td>
<td>286,847</td>
<td>1,851,210</td>
<td>720,920</td>
<td>3,396,600</td>
</tr>
<tr>
<td>1863</td>
<td>569,488</td>
<td>409,077</td>
<td>1,823,245</td>
<td>791,123</td>
<td>3,592,933</td>
</tr>
<tr>
<td>1864</td>
<td>786,905</td>
<td>697,864</td>
<td>2,172,388</td>
<td>802,089</td>
<td>4,459,264</td>
</tr>
<tr>
<td>1865</td>
<td>848,455</td>
<td>582,301</td>
<td>2,235,934</td>
<td>806,673</td>
<td>4,473,363</td>
</tr>
<tr>
<td>1866</td>
<td>1,485,248</td>
<td>880,888</td>
<td>2,051,044</td>
<td>943,445</td>
<td>5,360,625</td>
</tr>
<tr>
<td>1867</td>
<td>1,535,134</td>
<td>750,553</td>
<td>1,859,223</td>
<td>993,011</td>
<td>5,137,921</td>
</tr>
<tr>
<td>1868</td>
<td>1,834,113</td>
<td>911,807</td>
<td>2,038,593</td>
<td>1,083,376</td>
<td>5,867,889</td>
</tr>
<tr>
<td>1869</td>
<td>2,400,000</td>
<td>829,321</td>
<td>2,561,505</td>
<td>1,249,174</td>
<td>7,040,000</td>
</tr>
<tr>
<td>1870</td>
<td>1,509,371</td>
<td>773,902</td>
<td>2,649,277</td>
<td>1,456,532</td>
<td>6,389,082</td>
</tr>
</tbody>
</table>

Clearly this necessitated a vast increase in the staff of the Department which had hitherto consisted mainly of military engineers. The principal advantages of having public works undertaken by military engineers were that while officers escaped from the monotony of regimental life in peace time, and benefited from the advantages of civilian employment, they sacrificed none of their privileges as soldiers by so doing, and were held to be just as much a part of the regular forces as were the other branches of the Army. However, in 1861-62 it was decided that all officers employed on public works should be seconded to the I.P.W.D., their names being borne in italics in the Army List to signify that they had for the time forfeited all their rights to military command.

One effect of stigmatising the public works duty as a secondary sort of employment, as was done by placing the officers so employed on the seconded list, was that the military authorities were reluctant to entertain requests for increases of military engineers to that Department.
Similarly the inculcated traditions and early training of military engineers encouraged a belief in the superior importance of the so-called military duty: for example, when Sir William Dennison, as Governor of Madras, found the major part of the corps of Royal Engineers engaged during peace time in civil engineering duties (chiefly on irrigation works) he argued that this was not a proper mode of employing military engineers and recommended that the practice should be discontinued.  

Equally when the Government of India requested increases in the number of Royal Engineers, over and above the establishment fixed for India, the men were not supplied. In consequence the supply of Royal Engineers proved relatively inelastic to changing patterns of demand so that in the period 1861-1869 the total number of military engineers engaged in the I.P.W.D. remained relatively constant at 317 in 1861 and 363 in 1869.

More fundamentally however, there were many disadvantages to the employment of military engineers (during a period of expansion) on large scale civil engineering works, not least of which was the fact that only 65% approximately of the military engineers belonged to the Corps of Engineers: the rest were men from other branches of the Army (e.g. Artillery, Cavalry, Infantry, Staff Corps) whose main qualification was an enthusiasm for engineering. Indeed an analysis of several serious Barrack failures in the late 1860's reveals basic defects in the capacity of 'military engineers' to undertake large scale civil engineering works. Two examples of barrack failures, at Sagar and Allahabad, may be used to illustrate the defective composition of the military branch of the I.P.W.D., and this, when compounded by managerial ineptitude resulted in the Indian Government annually losing large sums of money.
The Code of Regulations of the I.P.W.D.\textsuperscript{13} outlined the procedure to be followed in barrack building. The general designs of barracks were established by a board composed of medical and military officers, under whom the I.P.W.D. prepared and issued standard plans for all barracks to be constructed. In each of the examples the site having been selected by the proper military authorities, the plans and estimates of the barracks were prepared according to the standard plans, and the final design was in both cases approved and sanctioned before execution by the Inspector General of Military Works, who was always an officer of the Corps of Royal Engineers.

The first example at Sagar Barracks\textsuperscript{14} occurred when shortly after their erection they became unsafe involving a loss of £166,000 to the State. In this case the barracks were designed according to the usual standard plans by Captain H.R. Faber, R.E. These plans and the necessary estimates were passed by the Chief Engineers, Colonel W. Maxwell, R.A., and Colonel A. Allen, S.C., and they were sanctioned by the Government of India when Colonel Crommelin was Inspector General of Military Works.

The barracks were erected entirely by Captain Faber under the superintendence of Colonel A. Allen and were inspected during construction by Colonel C. Pollard, R.E., and Colonel Crommelin. However when the barracks became unsafe, the Government instituted a Committee of Inquiry independent of the I.P.W.D. and presided over by Major General C.T. Chamberlain, C.S.I.\textsuperscript{15}

Following the Committee of Inquiry's report it was ordered that Captain H.R. Faber be dismissed from the I.P.W.D. and his services be placed at the disposal of the Military Department,
and Colonel C. Pollard was reduced from the rank of second to third-class Chief Engineer for one year. Although the superintending engineer, Lieutenant-Colonel A. Allen died before the inquiry was made, the Government of India noted "that Lieutenant-Colonel Allen's antecedents were not such as to justify his appointment to the post of Superintendent of Works at Jubbulpore. If a competent officer had filled that position it is probable that the defects in the construction of the barracks would have been remedied before they had become irretrievable".16

Of Captain Faber, the Committee reported that "his previous experience in the Department of Public Works had not been of such a nature as to bring his theoretical knowledge fully to bear on the practical details required for the construction of large buildings. .. Whoever has read the committee's proceedings, on the previous portion of this report, will have formed an opinion upon this officer's utter want of technical knowledge such as would fit him for the duties of an executive engineer charged with the departmental construction of large and important works".17 Moreover with regard to Captain Faber's powers of organisation and control the Committee noted, "an inspection of Captain Faber's order books and a consideration of his own evidence, as also that of Sargeants Wilkinson and Herbert, show unmistakably that Captain Faber is deficient in these essentials".18

The second example of a serious barrack failure occurred at Allahabad in June 1869 when a large store room attached to the Gun Factory collapsed during construction, killing four persons and seriously injuring seven others. This failure was made the subject of another inquiry by a special committee independent of the I.P.W.D. and presided over by Major General Travers, V.C.19 The Report of this committee attributed the
cause of the failure to the bad quality of the lime used — specimens of mortar taken from the walls containing, on analysis, only 6% of lime.20

The executive engineer, Major W. Jackson, S.C., under whom "the whole of the works which has failed was carried out" was "wanting in the qualities essential to a successful service in the Public Works Department". The report further notes "that the unfitness of this officer for the important post of executive engineer is borne out by the unskilful manner in which .. he designed an ordinary scarf for a beam; the error made was a very flagrant one, evincing ignorance of the elementary principles of carpentry". Major Jackson was removed from the Department.

With regard to the superintending engineer, Major Cobbe, R.A., the report argues that "the neglect of duty is more attributable to Major Cobbe than to any other of the controlling officers", and he was dismissed from the Department. Equally Lieutenant-Colonel Rose, S.C., another superintending engineer "must stand convicted on his own evidence of having signally failed to pay due regard to the responsibilities and duties of the important post of superintending engineer". Lieutenant-Colonel Rose was also dismissed from the Department. Lieutenant-Colonel Alexander, S.C., "has in consequence of his proceedings in this case, been placed in a grade lower than that in which he would otherwise have appeared". The Chief Engineer, Colonel Hodgson, was severely censured and the lime contractor was ordered to be prosecuted. The Report concluded with a note from His Excellency, the Governor General in Council, who "desires to record that he has viewed with great sorrow this deplorable history of negligence, incapacity and corruption".
The two examples of barrack failures outlined above constitute an extremely grave indictment of the military element in the I.P.W.D.\textsuperscript{21} The work involved clearly fell within the sphere of their own proper military engineering duties rather than difficult 'civil' works with which they might be unacquainted. Moreover the examples chosen do not represent one or two isolated cases of individual incompetence, but rather, men occupying every grade in the Department when judged by brother officers, were found wanting in some of the most elementary principles of civil engineering.

Clearly it would be unfair to impugn the whole of the military engineering profession on account of such failures, just as it would be to assail the professional integrity of the entire I.C.E. because of one or two Bridge failures. Nevertheless what is important for this study is that, although it may have been reasonable and economical in the early days of the I.P.W.D. (when all that was required was the construction of a few barracks, forts and roads) to entrust the management exclusively to military men, this did not apply from 1854 onwards when what was required was a predominantly civil department of the most energetic, flexible and progressive description and inspired by a large minded view of the nature of "reproductive expenditure" in public works. Thus, as large works of a more exclusively civil character became the norm it became increasingly necessary to employ 'civil' as opposed to 'military' engineers. This need was magnified in 1869 when a radical alteration of the system of financing "extraordinary" public works was proposed.\textsuperscript{22}

Prior to 1869 extraordinary public works such as essential lines of railway and a few irrigation projects were constructed through the agency of joint-stock companies with an English
domicile, to which the Government gave a guarantee of 5 per cent on the capital outlay and half the surplus profits. However a profound defect of these contracts was that the Companies were relieved of responsibility for the cost of construction and the only incentive to economy was the rather remote prospect of sharing in the profits. Even after allowing for the necessity of gaining experience in railway construction in India, the cost was high and for a number of years the payment of interest charges imposed a considerable burden on the general revenues.23

Consequently the Secretary of State for India (the 8th Duke of Argyll) proposed in 1869 to embark on a policy of construction through direct state agency, mainly with borrowed capital and in a Despatch to the Governor General of India he noted:

"I am myself disposed to think that as regards railways we might now dispense with the agency of companies altogether. We could raise the money on our own direct security at 4% whereas we guarantee 5% to the companies; and besides this we sacrifice our right to one half of any possible surplus of profits over and above the 5%." 24

By August 1869 this had become official Government policy and so tended to heighten the need for highly qualified civil engineers. However there were several obstacles to the recruitment of qualified civil engineers for service in India and, as a result, supply and demand were out of phase throughout the period 1850-1870. Before analysing the growth in the civil element in the I.P.W.D. and the concomitant impediments to further expansion, it is necessary to firstly consider the sources from whence such growth could be derived both in India and in Britain.
The Court of Directors of the East India Company, in their Educational Despatch of 1854, recommended the establishment of Indian Universities at Calcutta, Bombay and Madras which were subsequently incorporated in 1857. In their Despatch the Court of Directors noted, "civil engineering is another subject of importance the advantages of which, as a profession, are gradually becoming known to the natives of India, and while we are inclined to believe that instruction of a practical nature, such as is given in the Thomasson College of Civil Engineering at Roorkee, is far more useful than any lectures could possibly be, Professorships of Civil Engineering might, perhaps, be attached to the Universities, and degrees in Civil Engineering be included in their general scheme". By 1870 four engineering colleges had been established, at Madras, Poona (in the Bombay Presidency), Seebpore (in Bengal), and Roorkee (in the North Western Provinces).

The requirements of Madras University for the degree of Bachelor of Civil Engineering were that candidates should have passed the "First Examination in Arts" and have subsequently read for two years in an engineering college. All candidates for the degree were examined in Mathematics, Natural Philosophy, Mensuration and the framing of estimates, surveying and levelling, constructive engineering and architectural and topographical drawing.

In Bombay the University required of candidates for the 'Licence in Civil Engineering', (a) the Matriculation Certificate and (b) a course of three years study, which could be reduced in the case of candidates with higher initial qualifications to two years or to one and a half years. The examination comprised Mathematics and Natural Philosophy, experimental and natural
science, civil engineering, and one of the following list:
(a) analytical geometry and the differential and integral
calculus, (b) optics and astronomy, (c) mining and metallurgy,
(d) architecture, (e) mechanical engineering, (f) chemical
analysis, and (g) botany and meteorology. Instruction in the
University course, both theoretical and practical was given in
the Poona College of Science, which had attached workshops.

For the "Licence in Engineering of Calcutta University" a
candidate was required to have passed the entrance examination
and have subsequently studied for three years in an affiliated
institution. If he had passed the First Arts Examination, he
would be entitled to proceed to the degree of Bachelor of
Engineering. The course comprised the following subjects:
Mathematics, Engineering, Construction, Geodesy, Drawing and
either Natural Science or Machinery according as the candidate
selected Civil or Mechanical Engineering. The Civil Engineer-
ing College at Seebpore, near Calcutta, was the Institution
which prepared candidates for the University Degrees during a
course of five years.

However, the standard required at the above Institutions
was rarely achieved and indeed recruitment to the I.P.W.D. from
all three Universities seldom exceeded four engineers per annum.
A more important Institution, the Thomasson Civil Engineering
College at Roorkee was maintained entirely by the I.P.W.D.

In 1847, the Governor General of India, Lord Hardinge,
decided on the vigorous prosecution of the Ganges Canal which
was then estimated to take six or seven years to complete for
a total cost of some 10,000,000 Rupees. A minute of
23rd September 1847, from the Lieutenant Governor, North
Western Provinces, to the Governor General of India noted that
the site at Roorkee - on the banks of the Ganges - "affords
* e.g. Between 1864 and 1870 only five graduates in Civil
Engineering are recorded in the Madras University Calendars.
peculiar facilities for instructing civil engineers. There are large workshops and extensive and most important structures in the course of formation. There are also a Library and a model room. Above all a number of scientific and experienced engineer officers are constantly assembled on the spot or occasionally resorting thither.29 It went on to suggest that "These officers, however, all have their appropriate and engrossing duties to perform and cannot give time for that careful and systematic instruction which is necessary for the formation of an expert civil engineer".30

Thus, on the basis of a need for a "careful and systematic instruction" in civil engineering the College at Roorkee was established, under the auspices of the Hon. James Thomasson. The first Principal, Lieutenant MacLagan of the Bengal Engineers, was appointed on the 19th October 1847 and the original organization of the College is due to him.

The College was designed to give theoretical and practical instruction in civil engineering to Europeans and Natives, with a view to their employment in the I.P.W.D. "according to their several qualifications and the requirements of the State". With regard to officers of the Royal and East India Company, "well informed and highly educated men, who have much taste and capacity for civil engineering" could be given a systematic instruction so that "the certain discoveries of modern science would be substituted for the crude and mistaken notions which now prevail on all subjects connected with Natural Philosophy".31

The College was opened in 1848 in most inauspicious circumstances; the Second Punjab War (1848-1849) had begun, (diminishing the supply of students), and indeed, the Principal, Head Master and military students marched to the frontier. On the cessation of hostilities the Punjab was annexed but a tract
of land of approximately 78,000 square miles immediately adjoining to the North Western Provinces was added to the British Empire, in Hindustan, and the work of improvement commenced with much energy.

By 1851 the Principal proposed the enlargement of Roorkee College so that the work of improvement could proceed apace. The Principal argued that as the State's income was derived mainly from Land Revenue, clearly whatever added to the value of the land tended directly to increase that income. The total proposed expenditure for enlarging the College was 83,898 Rupees and the case was argued thus: "A private proprietor or landlord, when he counted the cost of a measure, which was calculated to exercise a material influence on the value of his property, would look not to its actual amount, but to the proportion it bore to the property affected. If the British Government were to argue thus, it would find that this attempt to train up an agency, necessary for the preservation and improvement of the country would cost \( \frac{1}{7} \)th per cent of the actual income derived directly from land. It would be equivalent to asking the owner of an estate in England, worth £10,000 per annum, to expend less than £15 in instructing some of his tenantry how to thorough drain his lands, when he could not otherwise procure skilful men for the work".\(^{32}\)

Roorkee College was subsequently enlarged so that by 1870 it contained the following classes and numbers of students - divided into three departments.\(^{33}\)

<table>
<thead>
<tr>
<th>First Department - Engineering Classes</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Officers</td>
<td>11</td>
</tr>
<tr>
<td>Civil (English)</td>
<td>29</td>
</tr>
<tr>
<td>Civil (Native)</td>
<td>6</td>
</tr>
<tr>
<td>Officers Surveying Class</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>46</td>
</tr>
</tbody>
</table>
The Engineering Class for Officers was designed for young commissioned officers of Artillery, Calvary and Infantry who were candidates for employment in the I.P.W.D. Prior to the establishment of Roorkee College such officers were not required to undergo any formal engineering training but due to such disasters in Public Works as those outlined above, this course became increasingly necessary. Applications for this course had to be addressed through one's commanding officer to the Principal at Roorkee and an entrance examination had to be passed involving Arithmetic, Algebra, Quadratic Equations and Geometry (to the first four books of Euclid) to demonstrate the candidate's capacity to undergo a course in civil engineering. However, officers of the Royal Artillery and those who obtained their commissions at Sandhurst, without purchase, were not required to undergo the entrance examination.

The engineering course for English civilians was composed of young men either trained at Indian Schools or Colleges, or prepared in England especially for Roorkee. Candidates were required to have passed the First Examination in Arts of the Calcutta University or an equivalent examination of any recognised College or University or an examination set by the Roorkee College.

<table>
<thead>
<tr>
<th>Department</th>
<th>Subordinate Classes</th>
<th>Military</th>
<th>Civil (English)</th>
<th>Civil (Native)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Department - Upper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subordinate Classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military</td>
<td></td>
<td>55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil (English)</td>
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<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil (Native)</td>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td>80</td>
</tr>
<tr>
<td>Third Department - Lower</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subordinate Classes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Military</td>
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<td></td>
</tr>
<tr>
<td>Civil</td>
<td></td>
<td></td>
<td>98</td>
<td></td>
<td>130</td>
</tr>
<tr>
<td>Mistree</td>
<td></td>
<td></td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of students</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>264</td>
</tr>
</tbody>
</table>
From the following outline of the University examination and the entrance examination at Roorkee, it will be seen that the former was considerably more difficult.

**Programme of the University Examination**

**Languages**: English and one of the following - Greek, Latin, Sanskrit, Hebrew, Arabic. Questions included translations, grammar and idiom.

**History**: Ancient history including some geography questions.

**Mathematics**: Pure and mixed; Arithmetic, Algebra, the four simple rules, proportions, simple equations, extraction of square root, greatest common measure, least common multiple, quadratic equations, proportion and variation, permutations and combinations, arithmetic and geometric progressions, the Binomial theorem, Simple and Compound Interest, Discount, Annuities, the nature and use of logarithms.

**Geometry**: The first four books of Euclid, sixth book of Euclid, the eleventh book to proposition XXI, deductions, plane trigonometry as far as the solution of triangles.

**Mechanics**: Composition and resolution of forces, equilibrium of forces at a point in one plane, the mechanical powers, the centre of gravity.

**Philosophy + Logic**: Psychology as in "Reids Inquiry", or in Abercrombie's "Intellectual Powers"; Logic as in Fowler.

The programme of the Roorkee Examination which could be passed in lieu of the above, embraced:-

**Languages**: English and either Latin or French.

**History**: England.

A short essay on a given subject.

**Geography**: General.

**Mathematics**: Arithmetic, Algebra (up to and including quadratic equations), Geometry (first four books of Euclid).

Candidates for Roorkee were further required to produce certificates to demonstrate good moral character and physical fitness and be between the ages of eighteen and twenty-four years.

A College fee of ten Rupees per mensem was payable from each student and "a monthly allowance of 80-100 Rupees should suffice for the ordinary expenses of English students of the first department".
The Engineer Class (native) consisted of "a few clever young men who have mastered the difficulties of the English language and have passed the University First Arts Examination". They each received a scholarship of fifty Rupees per month but up to 1869 this class was empty. However in 1870 the class received its full compliment of six students.

All students of the engineering classes were given the same course of instruction and attended the College for two sessions lasting nineteen months. The course consisted of the higher Mathematics and their special application to engineering purposes, the theory of civil engineering including the construction of buildings, bridges, roads, railways and irrigation works, estimating and designing, architectural and geometrical drawing, surveying and levelling (and practical astronomy), experimental science including chemistry, light, heat, magnetism, electricity, meteorology and photography.

In "civil engineering" the emphasis was on practical work: large models were used to illustrate the theory of construction, works in progress were visited and notes and sketches made thereon, and a large proportion of the second session was taken up with a project for a line of road, railway or canal between ten and twenty miles long, the surveys for which had actually been taken in the field, and the reports, drawings, estimates and specifications carefully prepared, exactly as they would be if the work was actually carried out. Indeed the Principal noted "we cannot actually construct bridges, etc., in order to train the students, but the instruction only stops short of this".

The following was the course of study for 1870, together with the marks assigned to each subject and the hours of attendance and arrangement of studies. The progress of students
was tested by a combination of monthly examinations and a final examination in each area of study. In this way it was possible for students to bring forward to the final examination a considerable number of marks to their credit.

The total number of marks obtainable for each subject were:

- Mathematics: 950
- Civil Engineering: 950
- Surveying: 400
- Drawing: 400
- Physical Science: 200
- Technical Urdu: 100

TOTAL: 3,000.

For the "Ordinary Certificate" a student was required to obtain not less than half the total number of marks and one-third of the number allotted to each subject. For the "Higher Certificate" not less than three-fifths of the total and half the number attached to each subject.

The syllabus for each subject and the marks attached to the monthly examinations - in brackets - were:

**Mathematics**: Arithmetic, algebra, geometry, trigonometry, mensuration, statics, dynamics, hydrostatics, hydrodynamics, co-ordinate geometry, differential and integral calculus.

**Monthly examinations**:
- January: Arithmetic (20)
- February: Algebra (20)
- March: Geometry (20)
- April: Trigonometry (30)
- May: Mensuration (20)
- June: Statics (30)
- July: Dynamics (20)

**Civil Engineering**: Materials and general constructions, special constructions (bridges, roads, railways, irrigation works, buildings), applied mechanics, machinery, estimating, ground tracing, notes on works, design.
Civil Engineering: (continued)

Monthly examinations:

<table>
<thead>
<tr>
<th>Month</th>
<th>1st Year</th>
<th>2nd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>February</td>
<td>Building Materials (15)</td>
<td>Buildings (10)</td>
</tr>
<tr>
<td>March</td>
<td>Masonry (15)</td>
<td>Bridges (20)</td>
</tr>
<tr>
<td>April</td>
<td>Carpentry (15)</td>
<td>Roads (10)</td>
</tr>
<tr>
<td>May</td>
<td>Earthwork (10)</td>
<td>Railways (10)</td>
</tr>
<tr>
<td>June</td>
<td>Applied Mechanics (20)</td>
<td>Irrigation Works (20)</td>
</tr>
<tr>
<td>July</td>
<td></td>
<td>Machinery (20)</td>
</tr>
</tbody>
</table>

Surveying: The surveying course was undertaken in the second year and embraced Surveying with Chain, Compass, Theodolite, and plane Table (150), Levelling and Contouring (100), Adjustment of instruments (25), Practical Astronomy (50), Questions in final examination (75).

Drawing: Architectural and engineering drawing (175), topographical drawing (75), isometrical, projection, perspective and free-hand drawing (75). Examination (75).

Physical Science: Course of lectures in Chemistry and Mineralogy, and instruction in practical analysis. Oral and written monthly examinations allocated 50 marks each leaving 100 for the final examination.

Students were timetabled for 30½ hours lectures each week in two sessions per day, viz. 10.00 a.m. to 1.00 p.m. and 1.30 p.m. to 4.00 p.m. for five days, and Saturday morning 10.00 a.m. to 1.00 p.m., was generally devoted to drawing. Ten hours per week were allocated specifically to "civil engineering" and was normally timetabled for four afternoon sessions.

The "Second Department" in the College, that for the "Upper Subordinate Classes", consisted principally of military students. Non-commissioned officers and soldiers, of good character, from the various regiments in India were admitted on passing an entrance examination in Arithmetic, Mensuration and Dictation.

It is notable that a considerable number of applicants were
rejected annually due to "defective character" and to failure in the entrance examination (a contributory factor being that most commanding officers were disinclined to part with valuable N.C.O.s who were regarded as "rare in most regiments").

These men lived in the College Barracks and were formed into two messes; they received a College allowance of 10 Rupees per month in addition to their ordinary pay, and were under military discipline. Generally they worked hard but occasionally cases of drunkenness had to be dealt with, and invariably a proportion found the work too difficult and were returned to their regiments.

The Civil (English) students in this department averaged about six per annum and came mainly from the Lawrence and Agra Asylums. They were admitted at eighteen years of age, on passing a similar entrance examination to that above, and were housed and messed with the soldiers. Most received a stipend of 30 Rupees per month which barely covered the necessary expenses.

A similar entrance examination existed for the Natives in this class but they were exempt if they had passed the University entrance examination. Six stipends of 10 Rupees each were annually awarded to the best candidates but "on the whole this class is not a very satisfactory one - the men have not, as a rule, a sufficient acquaintance with English, they are often deficient in physique and they are generally less intelligent than those who study in the lower subordinate class where no knowledge of English is exacted."

Students of the Upper Subordinate Classes all worked together and attended the College for only one session of 10 months. They were instructed in elementary mathematics, the uses of building materials and the theory of general
construction, estimating, levelling and surveying, and in geometrical drawing. A few volunteers attended lectures on experimental science and a small number received instruction in photography. After the final examination those who qualified received certificates as Overseers and appointments in the Public Works Department. The Military students were always appointed to the first grade, English civilians to the first or second grade according to age, and the Natives to the third grade.

The Lower Subordinate Class consisted entirely of Natives and instruction was given in the Urdu Language. The Military Class was begun in 1868 and was composed of sepoys who were admitted with a knowledge of Urdu dictation and simple arithmetic. Each man received five Rupees per month in addition to his regimental pay but the "decidedly low" standard, generally resulted in military students "passing out" with lower qualifications than their civilian classmates. On the other hand the civilian students were chiefly from the North Western Provinces, the sons of bunyahs, moonshees and others of the trading and writing classes and were admitted on passing an examination in Arithmetic, Geometry, Mensuration, History and Geography, Urdu dictation and elementary English. Ten scholarships of 10 Rupees per month and forty of 5 Rupees per month were awarded to the best students and all other students in this class paid a tuition fee of 1 Rupee per month.

These students were given a parallel course of instruction to that given to overseers except that it was conducted in the vernacular. However, because they spent two years at the College their proficiency in surveying, drawing and estimating was generally greater. In the second year they were drafted into three classes of "sub-overseer", "sub-surveyor", "estimators
and draftsmen" and training was made more specialised. Those who passed the final examination received certificates of qualification and appointments in the Public Works Department at from 25 to 30 Rupees per month. However, a notable feature of this class was "a want of physical strength for outdoor work" and a dislike of going too far from their homes for long periods.

The "Mistree Class" admitted any man who could bring a certificate that he was a good mason, carpenter or blacksmith and who could read and write Urdu, and who had a knowledge of the first four rules of arithmetic. He then received a stipend of 5 Rupees per month and free quarters, and was instructed in mensuration, drawing and estimating together with simple surveying and ground tracing. On completion of the course he was then appointed "Head Artizan" at 25 Rupees per month.

The establishment at Roorkee had, in addition to extensive college buildings, fifteen bungalows (allocated to engineering students) ten barracks for the soldier students and assistant masters, and barracks for the lower subordinate class. The College Library contained approximately 10,000 volumes and had a wide range of general reading material. However it was rich in engineering and scientific works and subscribed (among others) to the following periodicals: 39

Other extensive features of the College were its Museum and the "Central Instruments Depot" which supplied all surveying instruments used in Upper India. Moreover, a flourishing College Press produced work to the value of 50,000 Rupees in 1869, at a profit margin of 17%.40

The academic staff consisted of one Principal, two Assistant Principals, a professor of Experimental Science, a Professor of Mathematics, a Professor of Drawing and two separate staffs of masters for the Upper and Lower Subordinate Classes. The Principal and two Assistant Principals were officers of the Royal Engineers and although the Principal was not graded in the Public Works Department, his salary was equivalent to a first grade Superintending Engineer, with a house. The Chief Engineer, North Western Provinces, was ex-officio visitor to the College.

Of the Upper Subordinate Staff, which consisted of a Head Master and five assistant Masters, the former was graded a sub-engineer and the latter held the rank of staff-sergeants. All were chosen from the most distinguished of the past students (in this class). The Lower Subordinate Classes were staffed entirely by Natives (one Head Master and five assistant masters) and were also selected from past students.

Recreation and sporting facilities at the College included a Racket and Fives Court, gymnastic apparatus, Quoits, a skittle alley, Bowling Green and Croquet Ground, a cricket club and a rowing club with two four-oar boats on the canal.

With such elaborate facilities already in existence at Roorkee by 1871, it is clearly of fundamental importance to understand the factors which inhibited the expansion of Roorkee rather than the establishment of a new Civil Engineering College in England. From the following table it is evident that
Roorkee was primarily geared to the production of subordinate personnel for the I.P.W.D.

### TABLE VII

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1848</td>
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<td>1860</td>
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<td>10</td>
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<td>20</td>
<td>12</td>
<td>1863</td>
<td>4</td>
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<td>23</td>
<td>10</td>
<td>1864</td>
<td>9</td>
<td>15</td>
<td>11</td>
<td></td>
</tr>
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<td>1853</td>
<td>3</td>
<td>23</td>
<td>5</td>
<td>1865</td>
<td>5</td>
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<td>24</td>
<td>5</td>
</tr>
<tr>
<td>1855</td>
<td>6</td>
<td>17</td>
<td>20</td>
<td>1867</td>
<td>4</td>
<td>36</td>
<td>31</td>
<td>4</td>
</tr>
<tr>
<td>1856</td>
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<td>1868</td>
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<td>32</td>
<td>7</td>
</tr>
<tr>
<td>1857</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>1869</td>
<td>6</td>
<td>47</td>
<td>50</td>
<td>7</td>
</tr>
<tr>
<td>1858</td>
<td>2</td>
<td>26</td>
<td>37</td>
<td>1870</td>
<td>12</td>
<td>48</td>
<td>44</td>
<td>6</td>
</tr>
<tr>
<td>1859</td>
<td>11</td>
<td>14</td>
<td>27</td>
<td>1871</td>
<td>18</td>
<td>61</td>
<td>48</td>
<td>9</td>
</tr>
</tbody>
</table>

E.C. .. Engineer Class; U.S. .. Upper Subordinate Class; L.S. .. Lower Subordinate Class; O.S.C. .. Officers Surveying Class. (All figures refer to numbers of passed students.)

Thus, in the period 1848-1871 the engineers represented approximately 10.2% of the total output of Roorkee. Moreover the numbers reached by 1871 were regarded as a maximum under the existing accommodation and numbers of staff: hence any expansion of the College would have necessitated considerable additional expense. Indeed the cost per student in 1870 was estimated as: Engineer student 2,500 Rupees, Overseer student 600 Rupees, Sub-Overseer student 400 Rupees. In addition to this prohibitive cost, recruits were not forthcoming from India to the engineer class largely because of the paucity of secondary education provision. This, together with a built-in bias in the Colonial administration in favour of European recruits, focussed attention on Britain as the catchment area for recruits to the engineer corps, even if entering via
Roorkee. However, the expense involved in travelling to India to receive an engineering education with no guarantee of success precluded the possibility of Roorkee meeting the increased demand for engineers for the I.P.W.D.

With Britain as the fountain head for supplying the I.P.W.D. with civil engineers, efforts were made to tap the British sources at two distinct points. The first outlet consisted of experienced civil engineers and the second was aimed at men having recently qualified, either through pupilage solely or through an academic course combined with pupilage.

**Recruitment to the I.P.W.D. from British Sources**

The I.P.W.D. began to lose its exclusive military character about 1845 when two assistant engineers were attached to the Ganges Canal. In 1854 at the request of the Government of India several experienced engineers were sent out, and, although public works were suspended for the duration of the mutiny, when hostilities ceased (1859) further requests were made. The following table shows the composition of the I.P.W.D. at various times from 1840 to 1869.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MILITARY</th>
<th>CIVIL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>113</td>
<td>-</td>
<td>113</td>
</tr>
<tr>
<td>1850</td>
<td>176</td>
<td>7</td>
<td>183</td>
</tr>
<tr>
<td>1861</td>
<td>317</td>
<td>201</td>
<td>518</td>
</tr>
<tr>
<td>1863</td>
<td>308</td>
<td>237</td>
<td>545</td>
</tr>
<tr>
<td>1865</td>
<td>301</td>
<td>246</td>
<td>547</td>
</tr>
<tr>
<td>1867</td>
<td>298</td>
<td>304</td>
<td>602</td>
</tr>
<tr>
<td>1868</td>
<td>347</td>
<td>400</td>
<td>747</td>
</tr>
<tr>
<td>1869</td>
<td>363</td>
<td>533</td>
<td>896</td>
</tr>
</tbody>
</table>

Initially the policy of recruiting experienced civil engineers appeared to be a solution to the relative
inelasticity of supply of Royal Engineers to changing patterns of demand. However, such a solution soon brought many disadvantages, most notably, the experienced engineers were of mature age, unaccustomed to the climate and unacquainted with the language and customs of the country. Equally the introduction at irregular intervals of new, experienced engineers, caused friction within the Department (in regard to superiority, etc.) and in consequence, they did not settle easily into the existing structure of the I.P.W.D.

By 1859 it was clear that younger, more adaptable, but less experienced engineers were needed, and in the absence of any examinations or certificates from the I.C.E. to stamp a man as a good or bad engineer, it became necessary for the Public Works Committee in London to institute an examination to test the theoretical knowledge of engineers seeking employment in the I.P.W.D. This scheme was based largely on the recommendation of Sir Proby Cautley, (the Projector and Constructor of the Ganges Canal and a Member of the Council of India), that the staff of the Department should be recruited at the bottom by the appointment of young men selected annually by competitive examination. The scheme was agreed to by the Secretary of State for India, Lord Stanley, and on the 4th March 1859 the following advertisement was approved by the India Office for publication:

"Notice is hereby given that 24 junior appointments in the engineer establishment and 24 junior appointments in the upper subordinate establishment of the Department of Public Works in India are open to public competition."

Candidates between the ages of 18 and 22 years were required to produce certificates in regard to their health and moral character, and have passed not less than three years as articulated pupils to a civil engineer in practice.
Thus the system of recruiting "Stanley Engineers" by open competition, was inaugurated, and it took the form of an examination in the following subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>English and Anglo-Indian History and Geography</td>
<td>50</td>
</tr>
<tr>
<td>Algebra</td>
<td>60</td>
</tr>
<tr>
<td>Euclid - 1st, 2nd, 3rd, 6th, Books and the 1st 21 propositions of the 11th Book</td>
<td>80</td>
</tr>
<tr>
<td>Mechanics (Statics and Dynamics)</td>
<td>130</td>
</tr>
<tr>
<td>Hydrostatics and Hydraulics</td>
<td>130</td>
</tr>
<tr>
<td>Making working drawings of machinery, and plans, elevations and sections of buildings</td>
<td>120</td>
</tr>
<tr>
<td>Framing of estimates and specifications from given plans and data</td>
<td>70</td>
</tr>
<tr>
<td>Projects for bridges, locks, dams, roads and other engineering works</td>
<td>120</td>
</tr>
<tr>
<td>Trigonometrical surveying, comprising plane trigonometry and traversing with the theodolite</td>
<td>120</td>
</tr>
<tr>
<td>Land surveying with compass and chain and plotting from a field book</td>
<td>60</td>
</tr>
<tr>
<td>Levelling and use of instruments employed</td>
<td>60</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,000</strong></td>
</tr>
</tbody>
</table>

The Regulations stipulated that no candidate would be passed who did not obtain a minimum total of 600 marks. The 24 candidates who obtained the highest numbers above 600 would be ranked and appointed probationers in the "First Class" and could select to which of the three Presidencies they would proceed, providing not more than 12 went to Bengal, 6 to Madras and 6 to Bombay.

The scheme envisaged that on arrival in India, the probationers would be sent to one of the Civil Engineering Colleges recently established there, in order to acquire a colloquial knowledge of one of the native languages, and to receive further instruction in their profession. When pronounced sufficiently qualified by the President of the College, candidates were to be transferred to the effective establishment.
Under the precise terms of the instructions issued from the India office only one candidate passed the 1859 examination: the examiners observed that "the result of the recent examination has shown that if the standard of 600 is to be rigidly adhered to it will have the effect of excluding from the service many men possessed of capacity and practical acquirements which would be highly prized by the Government of India". In consequence, the examiners recommended 13 of the 15 candidates as suitable for employment in the I.P.W.D. and ascribed the poor results to "the absence of time for due preparation and for uncertainty as to the character and tone which the examination would assume".

At the following examination in 1860, "a marked improvement has been made manifest on the part of the competitors", 9 out of 28 candidates passed the requisite number of marks of 600. Moreover the highest number of marks awarded to the senior of this list of 9 was 830, and to the junior 605, while at the May examination in 1859, 603 was the mark obtained by the single successful candidate.

However, this optimism proved extremely ill-founded, both in terms of the quality and quantity of the successful competitors. In 1861 the Government of India remarked "only one of the five who went to Roorkee obtained the proportion required in the College examinations, although the range of subjects is much more limited than that demanded for the College standard. ... We cannot but feel anxiety as to the effect on the Department of the admission annually of so large a number of young men so imperfectly educated as these evidently are". Further Despatches in August and September 1861 observed: "Her Majesty's Government has taken measures to replace them (Engineer Officers) to a large extent, not with civil engineers
of experience, but with young men mostly of little or no experience, and of imperfect theoretical training. We do not see much advantage in this plan of sending out Civil Cadets under the name of probationers, seldom better qualified in practice than young engineer officers and inferior to them in most other branches of training.\textsuperscript{53} Again "We beg to repeat our request that the Presidency of Bengal may, as well as the other Presidencies, cease to receive a further supply of these probationers until we are able to speak from experience of the results of their employment".\textsuperscript{54} By April 1862 the issue had been identified as " .. we are rather doubtful to what extent any mere competitive examination can be trusted in the selection of persons for this sort of occupation".\textsuperscript{55}

This system of selecting engineers by means of open competitive examinations serves as an excellent example of the dichotomy which then existed between "theory" and "practice" in engineering education, and indeed its development may be viewed as a microcosm of the conflict between "education" and "training". Moreover, the Home and Indian Governments adopted postures which reflected this controversy: the Indian Government seeking "practical men" whereas the Home Government were implicitly arguing that theoretical subjects were indispensible to the practising civil engineer. Indeed the examiners appointed by the Home Government, when contemplating the significance of Mathematics, declared, "unless a certain standard of proficiency in this science is held to be indispensible, the system upon which candidates will be admitted into the engineering service will be found based upon erroneous principles".\textsuperscript{56}

They further observed, "we are aware of an impression that in the profession of civil engineering a practical knowledge of
details is infinitely more valuable than the possession of high Mathematical attainments and that, whereas the one is indis- pensible the other may with little or no disadvantage be ignored. But we contend, that Mathematics constitute the fundamental elements of all scientific knowledge, that the practical may always be engrafted upon the theoretical while it by no means follows that the converse position obtains, and that in our view, it seems running counter to the educational principles developed in all Scientific Collegiate Institutions of the present day to treat as secondary and unimportant that branch without some proficiency in which no engineer can with confidence project works or undertakings in the operation of which human life or interests, public or private, may be staked". 57

This statement tended to set the tone for future competitive examinations and its impact is remarkable in that, Mathematics became, de facto, the determinant of a competent civil engineer. However, it was in clear conflict with the requirements of the Government of India who regarded the successful competitors as "possessed of very inferior attainments". 58 Moreover when faced with the discrepancy between the June 1860 examination and that held at Roorkee College in March 1861, the examiners noted, "Mathematical papers are held by the Government of India to constitute 'a very imperfect test' - we are aware that the opinion entertained of them among the profession in this country is that they are too stringent, and open to objection by practical men as exacting as indispensible too great attainments in purely theoretical knowledge". 59

Despite this observation the examination requirements remained largely unaltered, and, the contextual significance of the complete failure of the competitive examination to satisfy the demands of the I.P.W.D. may be seen from the following
The table - (which illustrates the results of the competitive examinations from 1859 to 1870).

<table>
<thead>
<tr>
<th>YEARS</th>
<th>No. of appointments offered</th>
<th>No. of Competitors</th>
<th>No. of Competitors who passed the minimum qualifying test</th>
<th>No. of appointments unfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1859</td>
<td>24</td>
<td>15</td>
<td>1</td>
<td>23*</td>
</tr>
<tr>
<td>1860</td>
<td>15</td>
<td>28</td>
<td>9</td>
<td>6</td>
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<tr>
<td>1861</td>
<td>20</td>
<td>32</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>1862</td>
<td>10</td>
<td>40</td>
<td>16</td>
<td>-</td>
</tr>
<tr>
<td>1863</td>
<td>10</td>
<td>29</td>
<td>15</td>
<td>-</td>
</tr>
<tr>
<td>1864</td>
<td>10</td>
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<td>1865</td>
<td>10</td>
<td>16</td>
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<td>4</td>
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<tr>
<td>1866</td>
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<td>-</td>
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<tr>
<td>July</td>
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<td>-</td>
</tr>
<tr>
<td>1867</td>
<td>25</td>
<td>22</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Dec.</td>
<td>40</td>
<td>59</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>July</td>
<td>40</td>
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<td>1868</td>
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<td>40</td>
<td>70</td>
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<tr>
<td>1870</td>
<td>40</td>
<td>70</td>
<td>13</td>
<td>27</td>
</tr>
</tbody>
</table>

* Although 13 of the 15 candidates were appointed.

Thus out of a total of 319 appointments offered, 136 remained unfilled or approximately 43%.61

Clearly the prevailing system of engineering education must be regarded as a contributory factor to this failure. The principle of superimposing theoretical knowledge on to craft ability had been firmly established in Britain over many generations, and consequently the route to employment as a civil engineer was through the office or workshop of a practising civil engineer. This system was firmly rooted in the belief that "practical men are wanted, not mere theorists" but had several fundamental weaknesses, especially, (a) the absence of
any standard entry requirement, (b) the absence of thorough supervision of pupils, (c) the high fees payable for pupilage (infra Ch.1, p.28). To engineers trained under this system any test of theoretical principles was likely to prove a major obstacle.

In a scathing attack on the pupilage system, a leading civil engineer, J. Scott-Russell, argued "it was mostly reckoned politic and wise, that what knowledge a professional man had, he should carefully keep to himself as his capital in trade - sedulously avoiding everything which should give another man insight into those cunning mysteries which it had cost him so much to find out or create; and specially concealing those simple maxims and rules, which once found out would enable anybody else to be as wise as himself". In contrasting the English and German systems of engineering education he noted, "in my country many lucrative professions were still the craft of mystery men. In London, the ambitious youth who aspired to professional distinction had still to pay to the mystery man a fee of 100 to 500 guineas in order to be initiated into all the secrets of his profession, and here (Germany) I found them all taught, and better taught for the common sum of 60 Thalers a year or less than £10 per annum".

Other common observations of the pupilage system were, "neither the foreman nor the master usually took pains to teach the pupils anything and their position differed little from that of the ordinary workers, except for some social considerations". Further, "the foreman believed it was his duty to get as much work as possible out of the pupils and thus tended to keep them on repetitive work". Employers frequently refused to allow pupils to sketch machinery because of the fear of industrial espionage. Moreover, "they were given no
opportunity to learn costs of materials. Most of them wasted their time and attained no real proficiency. The system, moreover, excluded from the trade promising young men who had received excellent scientific training but were unable to pay the high premiums.\textsuperscript{66}

The bias in England in favour of perpetuating the pupilage system cannot be simply regarded as conservancy on the part of members of the I.C.E., or any similar hanging after tradition. The pupilage system was in many cases highly lucrative with individual engineers earning as much as 2,500 guineas a year from pupils in premiums.

However, in view of the results obtained from the "open competitive examination" system, it is plain that the pupilage system was a contributory factor to its inefficacy. Before substantiating this charge in detail it is necessary to consider other inhibiting factors to recruitment to the I.P.W.D.

The chief factors which tended to restrict recruitment to the I.P.W.D. were the inducements offered in the terms and conditions of employment. Despite the growth in the civil element in the I.P.W.D., illustrated in TableVIII, p. 62, the civil engineers did not share a corresponding increase in the control of the Department which continued to be vested in the hands of a small number of military men. Equally the civil engineers did not receive parity of remuneration with their military counterparts: the latter received in addition to their departmental salary the net military pay of their rank in the Army. Consequently several experienced engineers noted "we thus find a large centralised Government Department mainly composed of civil engineers almost entirely governed by a better paid and small body of Royal Engineers."\textsuperscript{67}
In 1868 the civil officers of the I.P.W.D. addressed a Memorial to the Governor-General of India upon the anomalies which existed in that Department, and the unfair treatment to which they were subjected in consequence. Because the civil engineers were regarded as uncovenanted servants the military engineers possessed marked advantages in regard to pay, social position, facilities for leave, retiring pensions, and in opportunities for promotion within the I.P.W.D. These advantages caused much resentment and anger to the civil engineers, who were unaware of the anomaly or entering the department but were jealously guarded by the military engineers.

The anomalies of pay are evidenced by the following table of monthly salaries (exclusive of travelling allowances) for the various ranks of the Public Works Department.

<table>
<thead>
<tr>
<th>Designation in the Engineer Establishment</th>
<th>Military</th>
<th>Civil</th>
<th>Difference in favour of Military</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RUPEES</td>
<td>RUPEES</td>
<td>RUPEES</td>
</tr>
<tr>
<td>Chief Engineer 1st Class</td>
<td>2,500</td>
<td>2,500</td>
<td>-</td>
</tr>
<tr>
<td>Chief Engineer 2nd Class</td>
<td>2,000</td>
<td>2,000</td>
<td>-</td>
</tr>
<tr>
<td>Chief Engineer 3rd Class</td>
<td>1,850</td>
<td>1,750</td>
<td>100</td>
</tr>
<tr>
<td>Superintending Engineer, First Class 1st Grade</td>
<td>1,800</td>
<td>1,600</td>
<td>200</td>
</tr>
<tr>
<td>Superintending Engineer, First Class 2nd Grade</td>
<td>1,650</td>
<td>1,400</td>
<td>250</td>
</tr>
<tr>
<td>Superintending Engineer, Second Class 1st Grade</td>
<td>1,550</td>
<td>1,200</td>
<td>350</td>
</tr>
<tr>
<td>Superintending Engineer, Second Class 2nd Grade</td>
<td>1,350</td>
<td>1,000</td>
<td>350</td>
</tr>
<tr>
<td>Superintendent of Works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,250</td>
<td>900</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>to</td>
<td>to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,650</td>
<td>1,400</td>
<td>250</td>
</tr>
<tr>
<td>Executive Engineer 1st Grade</td>
<td>1,250</td>
<td>900</td>
<td>350</td>
</tr>
<tr>
<td>Executive Engineer 2nd Grade</td>
<td>900</td>
<td>750</td>
<td>150</td>
</tr>
<tr>
<td>Executive Engineer 3rd Grade</td>
<td>750</td>
<td>600</td>
<td>150</td>
</tr>
<tr>
<td>Executive Engineer 4th Grade</td>
<td>600</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>Assistant Engineer 1st Grade</td>
<td>500</td>
<td>400</td>
<td>100</td>
</tr>
<tr>
<td>Assistant Engineer 2nd Grade</td>
<td>450</td>
<td>300</td>
<td>150</td>
</tr>
<tr>
<td>Assistant Engineer 3rd Grade</td>
<td>450</td>
<td>200</td>
<td>250</td>
</tr>
</tbody>
</table>

* In all statistics relating to this period the exchange ratio is given as 2 shillings the Government Rupee.
In addition to the above salaries military engineers received military pay from the Military Department, varying from £7 to £30 per month, depending on rank. Civil engineers generally agreed that Royal Engineers were entitled to such extra income but in the case of all other military officers (Staff Corps, Cavalry, Artillery, etc.) the extra increment was much resented.

Moreover, the civil engineers were overwhelmingly engaged in the lower echelons of the Public Works Department. The following table compares the pay of civil engineers to the average total pay drawn by military officers in such grades.

**TABLE XI**

<table>
<thead>
<tr>
<th>Rank in Department</th>
<th>Pay of Civil Engineer</th>
<th>Average total pay drawn by Military officers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive engineers, 1st Grade officiating as Superintending engineers of 2nd class</td>
<td>1,000</td>
<td>1,243</td>
</tr>
<tr>
<td>Executive engineers 1st Grade</td>
<td>900</td>
<td>1,080</td>
</tr>
<tr>
<td>Executive engineers 2nd Grade</td>
<td>750</td>
<td>898</td>
</tr>
<tr>
<td>Executive engineers 3rd Grade</td>
<td>600</td>
<td>746</td>
</tr>
<tr>
<td>Executive engineers 4th Grade</td>
<td>500</td>
<td>612</td>
</tr>
<tr>
<td>Assistant engineers 1st Grade</td>
<td>400</td>
<td>503</td>
</tr>
<tr>
<td>Assistant engineers 2nd Grade</td>
<td>300</td>
<td>454</td>
</tr>
<tr>
<td>Assistant engineers 3rd Grade</td>
<td>200</td>
<td>341</td>
</tr>
</tbody>
</table>

In terms of promotion to the higher grades the 1868 Memorial noted, "the last published Government list shows that out of thirteen chief engineers of all grades in Bengal, no civil one existed, twelve were military (Royal Engineers), one an Artillery officer, and out of thirty-three superintending engineers only five were civil. The rest were all Royal or native infantry officers". 70

Under these circumstances the Memorialists urged that
"Until the Government of India are pleased to remove the unfair and unreasonable anomalies which now exist, we earnestly call on the civil engineers at home to refrain from entering a service where they will not receive fair play, and with which, as things are, most of us deeply regret our connection, a connection the harder too to bear as we have divided ourselves from all home connection and professional chances, and are serving under pension and furlough rules we never can hope to benefit by".71

The Government of India proved unresponsive to the Memorialists requests for parity and in late 1868 and early 1869 the civils' complaints found expression in the columns of the press in both India and in England. Indeed the Journal "Engineering" remarked "year by year the field for engineering work is extended in India, but until responsible engineers in England can be freely induced to banish themselves, and enter the Government service, they must be assured of some better prospect than lies before the civil members of the I.P.W.D. at present, and have at least equal privileges and equal chances of advancement as the more highly favoured military servants of the Department".72

Relations between civil and military engineers in the I.P.W.D. further deteriorated when, on the 31st August 1869, the following notification from Government was issued at Simla.73

"Whereas the Governor-General in Council is given to understand that in the Civil Engineering profession in England, it is a recognised practice for Civil Engineers employed by public companies and otherwise, to receive, in addition to the salaries paid them by their employers, commission on contracts given out, or stores and materials ordered and inspected by them and other like pecuniary considerations for services done, or intended to be done, which are considered legitimate sources of emolument."

This notification in adding to grievances which had been
fermenting for several years provoked a storm of indignation. It was variously referred to as "the Simla Calumny", an "obnoxious notification", an "infamous instatement", and a "monstrous untruth", but its immediate effect was to remove what essentially was a local dispute, to a conflict between the Institution of Civil Engineers and the Secretary of State for India. Hence it was argued that "as a result of this indiscriminating aspertion" there is not a single member of the profession who will not feel his reputation assailed.

The implication that "professional dishonesty is a practice which is recognised as legitimate by the civil engineers of this country" roused the I.C.E. to request an urgent meeting with the Secretary of State for India, the Duke of Argyll, because "such an imputation, stamped as it is with high authority, is calculated to do grievous wrong to an honourable profession, and has created a deep and general feeling of indignation".

An interview was granted on the 27th October at which the I.C.E. declared "the Profession distinctly discountenances, repudiates, and condemns the practice implied in the notification" ... and "that it is a rule of the Institution not to receive into membership any person tainted or believed to be tainted, by any of the improper and corrupt practices alleged in such notification". Clearly the Institution could not argue that no corrupt persons had ever found their way into the profession, but such instances were highly exceptional and amounted to "flagrant departures from the well understood and well recognised practice of the profession" and therefore could not justify such a broad accusation.

Within a fortnight the Governor-General published a retraction, stating, "The Government of India unreservedly declares its complete confidence in the body of civil engineers
in its service" and proclaiming that it intended to recognize their merits and just claims as fully as those of any other class of its officers.

Finally, the adverse publicity generated by the inferior terms and conditions of employment for civil engineers in the I.P.W.D. (with a consequent lack of cohesion in that department) undoubtedly acted as an inhibiting factor to recruiting the most able candidates to the I.P.W.D. Indeed, of the twenty-two candidates who presented themselves for examination at the December examination in 1867, fourteen had already attempted the July 1867 examination leaving, in reality, but eight new candidates.

However, the effect of the Strachey Notification was to highlight the fundamental question, "how are public works to be carried out?". In a Leading Article the journal "Engineering" answered, "Not under the superintendence of the military clique, and not by the ill assorted staff, one portion of which assumes to itself undue importance, and excessive pay, whilst the other remains smarting under a sense of injustice, and works under protest; not by the importation of American engineers, but by the introduction of fresh vitality into the service, by obtaining the cooperation of able men, who will have assured to them a fair field and fair prospects, and by a special training of young engineers under the auspices of the India office".

To a correspondent of that journal the "way out of the difficulty has long been apparent to me" ... why should not the system under which officers of the Royal Engineers are trained be equally applicable to the case of civil engineers. Of course in this latter case a separate establishment would have to be formed, and maintained expressly for the purpose of training civil engineers for the Indian service. If well conducted, however, it might form the nucleus of an institution
in which many of our future engineers of eminence would receive their first instruction for the duties of their profession. Be this, however, as it may, we look to some sort of an arrangement whereby engineers shall be specially trained for their Indian service as the only method whereby the future demand can successfully be met."
CHAPTER 2

Footnotes.


3. The Departments were Ordnance, Stud, Commissariat and Public Works so that typical examples of the composition of the Board included : the Commissariat General, Commanders of Artillery, Cavalry and Infantry and the Chief Engineer. For detailed examples see the "East India Register and Army List" (for years prior to 1854) under 'Military Board' for each Presidency. The Register was published annually by W.H.Allen & Co., London.

4. This argument was later applied to many of the railways : e.g. "India is now covered with a rapidly extending network of railways by means of which forces can be moved to any part of it with ease and rapidity and a concentration of troops on any given point may now be accomplished in as many days as it would formerly have taken months" (Military Despatch from India No.217 of 1890, para.7). However, prior to the 1850's roads were planned and executed essentially as military undertakings whereas the military significance of railways was not always the primary consideration.

5. The annual expenditure on Public Works was divided into two headings "ordinary" and "extraordinary" which comprised the charges defrayed respectively from current revenue and funds obtained by loan. The expenditure referred to in the following table refers only to ordinary expenditure.

6. Extracted from "Statistics Relating to India" prepared by M.Horridge of the Statistical Department of the India Office, June 1871, p.30. In fact the year 1867 embraces 11 months only, due to a change in the termination of the official year from 30th April to 31st March.

7. Prior to this date the Indian Army consisted of the following main parts : The Native Army, the Local European Army (composed of the white soldiers permanently quartered in India) and Her Majesty's Forces in India. The Native and Local European Armies on the one hand and Her Majesty's Forces on the other, had their separate General Staff with separate subordinate establishments in each Presidency. However following the Mutiny it was decided to abolish this duality and streamline the administration by amalgamating the General Staff. For further detail see K.M.L.Saxena, "The Military System of India (1850-1900)" (New Delhi : Sterling Press, 1974) pp.24-56.
8. Confidential Memorandum from Col. Chesney, R.E. to the Secretary of State for India, on "The Employment of the Royal Engineers in India considered with reference to the Civil Engineering College" dated, India Office, December 1870, contained in 1OR/L/PWD/8/B.

9. Ibid.

10. See the Appendix to "Parliamentary Paper 148 of 1871" (op. cit - footnote 2) p.13.

11. The example of barrack failures is chosen because it was later used by the Duke of Argyll in a discussion in the House of Lords on a motion of Lord Belper - and reported in "The Times" on 16th July 1881 - as a contributory factor in favour of the establishment of the R.I.E.C.

   The Duke of Argyll did not originally intend to distinguish between 'military' and 'civil' engineers and indeed his remarks called forth a hostile reaction from the I.C.E. in the form of three separate articles in "Engineering". These three articles together with the correspondence between His Grace and the President of the I.C.E. (James Abernethy) were collected and published by E. & F.N. Spon (London) in 1882. However, as will be seen below the example of barrack failures may be used to illustrate a fundamental defect in the staffing of the I.P.W.D. See the Duke of Argyll's letter to James Abernethy dated "Inverary, 7th December 1881".

12. Indeed the Duke of Argyll declared that "on one occasion some millions were spent under the direction of the Engineers of India in the construction of new barracks. It turned out however, that these buildings had been erected in accordance with entirely erroneous principles, and that they were mere 'sun-traps'. They were tremendously hot and in consequence the health of the troops quartered in them suffered severely. Many of them were so insufficiently built that it was found that they would not last for more than a few years, and in some cases even the line that had been used was pronounced to be bad. In this way the Indian Government were annually losing hundreds of thousands of pounds in bad engineering. The insufficiency of the engineering service having been brought prominently before the notice of the India Office, the authorities formed the idea of the erection of Cooper's Hill College". Hansard's Parliamentary Debates, 3rd Series, Vol.CCLXIII, 15th July 1881, Column 997-998.


14. The Sagar Barracks were begun in February 1866 and by 1870 basic inadequacies and defects were evident. However it was not until 1872 that the buildings were pronounced a total failure.
15. The other committee members were Mr. H.P. Le Mesurier and Lieut.-Colonel P.J. O'Connell. Their report was most exhaustive covering some 200 pages. See the "Report by the Committee on the failure of the new British Infantry Barracks at Sagar". The Report and Appendices are included in "The Extra Supplement to the Gazette of India" dated 12th November 1872 (pp.1-211). See also "The Gazette of India" for 7th December 1872 entitled "Failure of the New British Infantry Barracks at Sagar".

16. The Orders of the Government of India are included in the "Gazette of India" for 2nd November 1872 pp.1024-1027.

17. Ibid, p.1025 para. 5.

18. Ibid.

19. Members: Colonel J.C. Anderson and Mr. R.M. Brereton.

20. The Committee's Report is contained in the "Supplement to the Gazette of India" dated 3rd December 1870, pp.1330-1342, entitled, "Report of Special Committee upon the Defects in the new barracks and other buildings at Allahabad", dated 30th November 1870.

21. The designatory initials are included for each officer to indicate to the reader the corps to which they were attached.

22. For further detail see "The Cambridge History of India" in six volumes. Volume 6 "The Indian Empire 1858-1918 and The Last Phase 1919-1947" (Delhi, S.Choud and Co., 1958).


25. For a copy of the Despatch see Parliamentary Paper 393 of 1854, "Return to an Order of the Honourable the House of Commons dated 18th July 1854", being "A Despatch to the Government of India on the subject of General Education in India". Ordered by the House of Commons to be printed 20th July 1854. In fact this despatch, based on the recommendations of the Select Committee of both Houses of Parliament into Indian Affairs (1852-1853), recommended the University of London as a model for the Indian Universities on account of the non-sectarian character of its system.

26. Madras University Calendar 1870-1871. (Printed for the University by Caleb Foster, Vepery 1870.)

27. Although a Bombay University Calendar is not available for 1870, (nor one for the Roona College of Science), a historical description of their engineering requirements is contained in Syed Mahmood's "A History of English Education in India. Its rise, development, progress and present conditions and prospects (1781-1893)". See Chapter XXV and XVII for an account of the establishment of the Indian Universities and the scope and character of the education
27. (continued) recognised and controlled by them, (with statistics of University Collegiate Education from 1857 to 1882), published by the Mayo College, Aligarth, 1895. For a brief description of the Poona College see "The Engineer" Volume 20, 6th October 1865, p.222, entitled "An Engineering College for Western India".

28. For course content see Mahmood (op.cit.) The Calcutta Civil Engineering College was first affiliated to the University of Calcutta in 1857. See "A Hundred Years of the University of Calcutta" (Supplement), published by the University of Calcutta 1957 - Editor, Professor P. Banerjee, (p.18).

29. "Account of Roorkee College, Established for the instruction of civil engineers, with a scheme for its enlargement" (Agra, Secundra Orphan Press, 1851). A brief history of the Thomason College is contained in the "Thomason Civil Engineering College Calendar for 1920" (Allahabad, Government Press 1920) pp.14-27. This College became affiliated to the University of Calcutta in 1864 ("One Hundred Years of the University of Calcutta", op.cit. pp.28-29).

30. Ibid. "Account of Roorkee College ... 1851".

31. Ibid.

32. Ibid.

33. "Prospectus of the Thomason Civil Engineering College, Roorkee (printed at the College) dated Roorkee 1869.

34. See "Madras University Calendar 1870-1871". (op.cit. footnote 26).

35. See the "Roorkee College Calendars" for 1867 and 1869.

36. Memorandum on the "Thomason Civil Engineering College, Roorkee" by Lieut.-Colonel J.G. Medley, R.E., Principal (dated Roorkee, 15th December 1870).

37. Ibid.

38. Ibid.

39. See the "Thomason Civil Engineering College Library Catalogue" and the "Supplement to the Catalogue, corrected up to 31st March 1869".

40. A notable section of the publications was a series of "Professional Papers on Indian Engineering" published by the College from 1863 onwards.

41. Compiled from the 'yearly lists of passed students' in the "Thomason Civil Engineering College Calendar 1870-1871" (printed and published by the College Press, Roorkee 1871) pp.61-113.

42. Indeed the Principal noted in his annual report in the "Thomason Civil Engineering College Calendar 1871-1872" (pp.265-286) that, "I would not under present arrangements
42. (continued) wish to see these numbers increased", p.268. Moreover, as Government employment was only guaranteed to eight engineering students per annum, this must be regarded as a further inhibiting factor on any possible expansion at Roorkee.

43. "Memorandum on the present state and future prospects of the Thomason Civil Engineering College, Roorkee", by J.C. Medley (1870).


45. "Engineering Examinations 1859-1866, Volume 1". 1OR/L/PWD/8/1 p.3.

46. This condition was, clearly prejudicial to the interests of the existing schools and Colleges with engineering departments, in that they were excluded from the competition. However, following a Memorial and two Deputations from Trinity College Dublin in 1859, the conditions of entry to the examination were altered to include "gentlemen holding diplomas of recognised schools of engineering shall be permitted to compete; such Diploma guaranteeing a course of at least two years of engineering studies; provided that they furnish also satisfactory evidence of having served an additional year with a civil engineer in practice". See below Chapter III, pp.144-145. The subsequent appeals for "recognition" from a medley of "schools" ranging from "Messrs. Hyde, Smith and Lewis Civil Engineering College, 24 Guildford Street, Russell Square" to the "University of Glasgow", are contained in the bundle of documents 1OR/L/PWD/2/222.

47. "Engineering Examinations 1859-1866, Volume 1" (op.cit. footnote 45).

48. The pass mark was therefore set at three-fifths of the total marks obtainable. However, an extremely high proportion of the total marks (two-fifths) were allocated to Mathematics and if the History and Geography papers were excluded, this left, in reality, but 550 marks for engineering and surveying combined. Ibid, p.3.

49. The examiners were, the Rev. Jonathan Cape, A.M., F.R.S. (Professor at the Military College, Addiscombe); George Preston White, Esq., C.E., and Captain J. Ouchterlay from the Madras Engineers, temporarily teaching at Addiscombe. Their Report is dated 17th May 1859 (see 1OR/L/PWD/8/1 pp.5-10).

50. Ibid.

51. See the "Report from Examiners to the Under Secretary of State for India" dated 18th June 1860 (1OR/L/PWD/8/1) p.36.

52. "Public Works Despatch from the Government of India, No.34" dated 28th May 1861. See extract in the papers of the 8th Duke of Argyll (photographed by D.L. West, 11th February 1955, Reel 324-45). 1OR/L/PWD/95/54.


55. "Public Works Despatch from the Government of India No.18" dated 11th April 1862.

56. The Examiners were: Rev. Jonathan Cape, Captain J. Ouchterlany (both Professors at the Military College, Addiscombe) and George Preston White, C.E. See 1OR/L/PWD/8/1, pp.7-8. (As in footnote 49.)


58. Quoted in a letter from the Examiners to the Under Secretary of State for India dated 12th August 1861 in 1OR/L/PWD/8/1, p.66.


61. In consequence, the Home Government reverted to the policy of recruiting experienced engineers for temporary higher grade appointments from time to time during the 1860's. In fact between 1865 and 1870 the total number of civil engineers in India increased by 287, of whom 132 were selected at ordinary competitive examinations, 80 were selected for temporary appointments in some of the superior grades making 212 sent out from England, leaving 75 for promotions of subordinates and other appointments in India.


64. Quoted in the extract from evidence given by Professor Fleeming Jenkin before the Select Committee on Scientific Instruction, 1868. In Parliamentary Paper 148 of 1871. (Appendix pages 13-14.)

In the late 1860's (especially from 1867 onwards) the technical press became inundated with critical comments on the pupilage system which was described variously as "make-shift" (Engineering, Volume 4, 1st November 1867, p.415) and a "bungling means of engineering instruction" (Engineering, Volume 3, 24th May 1867, p.536).

65. Fleeming Jenkin's evidence (op.cit., p.14), he also noted "I remember passing six weeks doing nothing but polishing those brass valve boxes that you see outside locomotives", 
65. (continued)
a remark supported by "Engineer" (Volume 3, 24th May 1867, p.536). "In a large office the work is of necessity sub-divided, and each pupil only gets a bit, and the 'governor' has absolutely no time, and often but little inclination, to attempt anything like instruction, still less to instil the broad principles which regulate engineering judgement".

66. Of the starting salary of £200, "Engineering" commented in an editorial "it is well known, especially to those who have experienced it for themselves, how excessively difficult it is to provide even bare necessities of life in India upon £200 a year, and it is not therefore to be expected that men possessing qualifications that would enable them to earn a livelihood in this country, would offer for Indian Service except upon such terms as would enable them to live in that country". "Engineering", Volume 6, 24th July 1868, p.81.

Indeed as evidence of the poor quality of candidates forthcoming it is notable that many were extremely deficient in dictation". See the Examiners Reports for 10th June 1862, 9th June 1863, and 6th June 1864 in 1OR/L/PWD/6/1, pp.102, 131 and 149 respectively.


69. The civil engineers in the I.P.W.D. submitted a Memorial to the Governor General of India in Council calling upon the Government of India to rectify the anomaly in their terms and conditions of employment. The Memorial is reproduced in "The Engineer", Volume 27, pp.90-91, 29th January 1869. Also in the "Argyll Papers" at the India Office.

70. See "Engineering", Volume 11, p.218, 24th March 1871. See also the abstract of the classified list of officers in the I.P.W.D. corrected up to April 1867, reproduced in "The Engineer", Volume 26, p.365, 13th November 1868.

71. For a copy of the Memorial see "The Engineer", Volume 27, (op.cit. footnote 69) pp.90-91.


73. See "Public Works Department Notifications" No.242 dated 'Simla, 31st August 1869', in the Gazette of India for 4th September 1869. See also "Engineering", Volume 8, p.308, 5th November 1869, and 29th October 1869 pp.291 and 296.

74. Ibid, p.308.

75. "The Engineer", Volume XXVII, pp.90-91, 29th January 1869. Plainly reputable engineers would not seek employment with an employer who vilifies them collectively ...

76. Letter from Charles Hutton Gregory, President of the I.C.E., to the Duke of Argyll, Secretary of State for India, dated 23rd October 1869. ("Argyll Papers") Also in "Engineering", Volume 8, p.308, 5th November 1869.
77. Ibid. In fact this constituted paragraph 4 of a unanimous resolution of the Council of the I.C.E. on the subject.

78. Following the interviews the President of the I.C.E. wrote to the Secretary of State for India to reinforce the points discussed. Letter from Charles Hutton Gregory to the Duke of Argyll dated 27th October 1869. ("Argyll Papers"). Correspondence between Argyll and Gregory on this issue is also reproduced in "Engineering", Volume 8, 5th November 1869 (op.cit. footnote 73), p.308.

79. Ibid.

80. "Engineering", Volume 8, p.340, 19th November 1869. See also "The Times of India" for 20th November 1869.


82. Ibid, 29th October 1869, p.296.
CHAPTER 3

The origin of the Royal Indian Engineering College

Two phases are evident in the process of establishing the Royal Indian Engineering College (R.I.E.C.) at Cooper's Hill in Surrey in August 1871. The first which opens in the spring of 1869 and closes in July 1870, is concerned with the leading personalities involved in mootng the concept of State participation in the education of engineers destined for the I.P.W.D. The second which begins with the final ratification of the decision to establish the College in July 1870 and ends with its inauguration in August 1871, deals with institutional and personal responses to the idea of State involvement in professional civil engineering education. Both are inextricably interwoven but for purposes of exposition it is useful to consider the steps leading to the establishment of the R.I.E.C. in this conceptually distinct manner.

One of the most significant figures in the debates about engineering education taking place at the India Office was Colonel George Tonkyns Chesney, the examiner in surveying whilst on furlough in England from the Indian Army from 1867 to 1869. Since Chesney plays a prominent part in the establishment of the R.I.E.C., his views, which arose in part from his experience as an examiner, must be considered here.

Born on the 30th April 1830 at Tiverton in Devonshire, he was educated at Blundells School in Tiverton and at Mount Radford School near Exeter. His conduct at school was pronounced "entirely satisfactory, his diligence and application to his studies, highly commendable. Of this no better proof can be given than the fact of his having carried off one or more prizes at the end of each half-year." At first he had a leaning for the medical profession, but, on receiving an Indian Cadetship, he
went to the Military College of the East India Company at Addiscombe in February 1847, and received a commission as second lieutenant in the Bengal Engineers on the 8th December 1848. Following his professional instruction in civil engineering at the School of Military Engineering in Chatham, Chesney went to India arriving in December 1850 where he was employed in the Public Works Department.

He was wounded in the Siege of Delhi, where he distinguished himself and was mentioned in despatches. On recovering from his wounds he was posted to Roorkee where he was made a Professor at the Thomasson Civil Engineering College, a task eminently suited to his abilities. In 1860 he was appointed Head of the Accounts Department (of the I.P.W.D.) and immediately undertook a radical overhaul of an antiquated accounting system. When in 1867, he went on furlough to England he retired to Harrow on the Hill to complete his 'view of the system of administration in India' which was published the following year entitled "Indian Polity". His commissions to 1870 were dated Lieutenant 1st August 1854, Captain 27th August 1858, brevet Major 28th August 1858, and brevet Lieutenant-Colonel 14th June 1869.

When the heightened interest in reform of engineering education quickened as a result of the Paris International Exhibition of 1867 and was fuelled by vigorous debates in the columns of "The Times" and the technical press, Chesney was deeply impressed by the debate.

His views on civil engineering education, enhanced as they were by his experience as a military engineer, a teacher at Roorkee, Accountant General and finally as examiner in Surveying, were clearly such as could command respect, and when, early in 1869, he threw himself wholeheartedly into the 'theory versus practice' controversy, he emerged as a conciliator but heavily in favour of a greater scientific education. Chesney held that
the so-called practical system had produced many excellent engineers such as Tredgold, who started life as a carpenter, Brindley who built the Bridgewater and Mersey Canals began as a millwright, Telford who built the Holyhead Road was trained as a stonemason and Smeaton who built the Eddystone Lighthouse was apprenticed as an instrument maker. However, to advocates of the existing 'laissez aller' arrangement, who pointed to the men it had produced as sufficient evidence of its excellence, Chesney replied that systems of education were not needed for such men of genius, for they would emerge under any system. Nevertheless for the rest of the corpus of engineering he observed, "the mere fact that a man has served an apprenticeship to an engineer is obviously no guarantee whatever that he has made good use of his time, and there is no system of degrees or diplomas in the engineering profession to stamp a man as having attained a certain standard of acquirements. In fact the difficulty that besets the question is one inherent in the irregular training the young civil engineer receives, who is in most cases left to acquire, or fail to acquire, a knowledge of his profession just as he pleases".7

This view, it seemed, was emphatically endorsed by the results of the competitive examinations for entry to the I.P.W.D. and especially by the comments of the other examiners. Thus, at the December examination in 1868 the number of appointments to be made was announced to be "40 or as many more as may be required at that time for the public service".8 The number of candidates was 44 and of these 20 were recommended as qualified for appointments. In commenting on the quality of the candidates, Dr.Wrigley,9 one of the examiners and Headmaster of Clapham Grammar School noted, "the Mathematical knowledge and skill evinced were not in any case more than mediocre. The
principles and processes of pure and mixed Mathematics were but little understood, even within the limited range prescribed. The examination in Surveying yielded no better results. I have reason to believe that the examination questions in this subject were simple and easy, but the answers evinced knowledge, even in this range, not better than crude and imperfect.\textsuperscript{10} Chesney, in concurring with this view observed that "to engineers as now trained, any test in theoretical principles will be likely to prove a stumbling block."\textsuperscript{11}

However, Chesney may be accused of over-simplifying his case in stating that there was no system of degrees or diplomas in the engineering profession. Certainly none were fully endorsed by the Institution of Civil Engineers but in fact science degrees were awarded by most Universities in Britain by 1869. The Oxford Honours Schools in Mathematics and Natural Sciences were introduced in 1850 and the Cambridge Triposes in Moral and Natural Sciences in 1851, and, in 1860 after the renewal of its Charter in 1858, the University of London introduced Science Degrees which were open to all comers, irrespective of whether they had attended a College or not, thus, for example, enabling candidates from Owens College Manchester (1851) to take London B.Sc's. Similarly the University of Edinburgh introduced a Chair of Engineering in 1868 to which Professor Fleming Jenkin was elected.

Moreover, the following list of Schools and Colleges were recognised (1870) by the Secretary of State for India as possessing efficient classes for instruction in engineering.\textsuperscript{12}

\begin{tabular}{|l|l|}
\hline
ENGLAND & \\
University College, London & Rossal School, Fleetwood \\
King's College, London & School of Practical Science and Metallurgy, Sheffield \\
Wimbledon School & Hartley Institute, Southampton \\
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### ENGLAND (cont'd)

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<th>Institution</th>
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<tr>
<td>Royal Military Academy, Woolwich</td>
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<td>Proprietary College, Bath</td>
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<td>Queens College, Liverpool</td>
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<td>Owens College, Manchester</td>
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<td>The College, Cheltenham</td>
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<td>Government School of Mines, Jermyn Street</td>
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<td>Elizabeth College, Guernsey</td>
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<td>The College, Chester.</td>
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### SCOTLAND

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<td>University of Glasgow</td>
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<td>Madras College, St. Andrews</td>
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<tr>
<td>Edinburgh University</td>
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<tr>
<td>Perth Academy</td>
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<tr>
<td>High School, Edinburgh</td>
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<tr>
<td>Messrs. E. Sang and Son, 2 George Street, Edinburgh</td>
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<tr>
<td>Dollar Institution by Sterling</td>
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<td>Mr. Rennets School, Aberdeen.</td>
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### IRELAND

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<td>Queens Colleges, Cork, Belfast and Galway</td>
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<tr>
<td>Trinity College, Dublin</td>
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<tr>
<td>Royal College of Science for Ireland.</td>
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Chesney had little regard for many of the above Institutions and later argued that recognition "was undoubtedly bestowed much too readily". Nevertheless he stressed the need for engineering to keep pace with developments in science and consequently favoured a formal academic institution for the training of civil engineers. As evidence of the 'rule of thumb' work which then prevailed in Britain, he noted that "no two engineers are as yet agreed about the best form for, say, an iron bridge, of any given span. One prefers a lattice girder, another a plate girder, a third some kind of arch. But none can give a demonstrative reason for the faith that is in him". In contrast he observed that "in every other country engineering is regarded, not as a mere trade, but as a scientific profession, and that the idea is gaining ground in England also; and it may
be confidently predicted that before many more years have passed, a more methodical system of engineering education will have everywhere become established".

This conviction that every engineer should be thoroughly conversant with the principles of his profession represents Chesney's first major contribution to the 'theory versus practice' controversy. However, he was cautious in his advocacy of a greater theoretical education (in fear of 'throwing out the baby with the bathwater') as, "engineering is before everything a matter of practice, and a man is no more fit to be called an engineer who has had no practical training than a man is fit to be employed as a doctor who has never been brought face to face with disease, but has gained his knowledge of it only from books". Hence the theoretical education was to be bound in by experience. His second contribution was in recognising that the employers of professional engineers could give an enormous impetus to engineering education by positively discriminating in favour of those with a combined theoretical and practical background. In the absence of action by the I.C.E. to promote such a cause, Chesney was led to consider the role of the largest employer of professional engineers - in India - the State. However, as the test for entry to the I.P.W.D. had "proved a failure" both in terms of supplying India with the quality and quantity of engineers required for the execution of public works, he foresaw a clear need for State involvement in professional civil engineering education.

Nevertheless, it is conspicuous that in his analysis of the limitations of the 'open market system', Chesney placed overwhelming emphasis on the deficiencies of the pupilage system and totally ignored other significant variables such as the defects in the examination itself, or the relatively poor inducements
offered to successful candidates.

On the 22nd February 1869 Chesney submitted formal proposals, to the Secretary of State for India, for the establishment of a College (near London and under State patronage) for the education and training of civil engineers destined for work in the I.P.W.D., and noted in passing, that he was aware that the very name of a College for engineering would be utterly abhorrent to the ideas of most civil engineers.

His scheme envisaged an open competitive entry examination in the ordinary subjects of English education, namely, Mathematics, Classics, Modern Languages, History, Physical Science and Drawing, followed by a course of three years in "the proper subjects of professional study" which he divided into:

1. Applied Mathematics and Mechanics of Engineering
2. Theory of Engineering
3. Physical Science
4. Surveying
5. Drawing
6. Construction.

The suggested course of study embraced:

**First Year**

Winter Session : Drawing, Mathematics and Mechanism, theory of engineering, physical science.

Spring and Summer : Surveying - a six-month course.

**Second Year**

Winter Session : as before but including estimating.

Spring and Summer : Railway and road surveying, pupillage with a mechanical engineer in a workshop

**Third Year**

Winter Session : as before.

Spring and Summer : pupillage with a civil engineer employed on actual works.

This early model of a 'thin sandwich' course was initially intended for 25 students per year. Moreover, the cost to
Government would not be very great as Chesney suggested that the friends of the selected candidates would be prepared to pay at least £100 per annum for their education. However it could be argued that this call for State involvement in professional civil engineering education was not consistent with the prevailing economic philosophy of laissez faire. In this context many writers embrace the example of the Chancellor of the Exchequer's (Robert Lowe) reply to a deputation from the Scottish Meteorological Society (1869) seeking financial assistance, when Lowe declared that he was totally opposed to all grants and would not entertain any applications of that nature. Thus, "I hold it our duty not to spend public money to do that which people can do for themselves". On the other hand it has been argued that by the 1870's Victorian Governments were attuned to the idea of State intervention in special circumstances, and indeed that they were not parsimonious in their benevolence towards science. These special circumstances included inter alia, trigonometrical, geological and hydrographical surveys and indeed various astronomical observations. In consequence the role of the State was by no means as clear-cut as has been widely supposed, and, in an analysis of "The Evolution of Technical Education in nineteenth century England", P.Keane argues that the very multiplicity of 'special cases' eventually called for definite policies and thus ended the era of laissez faire. What is important for this study, however, is that the notion of state intervention must be considered against a backcloth of an Imperial requirement to exploit and develop the dominions.

In this sense perhaps the most significant figure involved in the political sphere was the Secretary of State for India, the 8th Duke of Argyll, who supported a modified version of
Chesney's original proposal and established a College (within two years) specifically to train civil engineers for service in the I.P.W.D. Under the auspices of the Government the College incurred a total capital expenditure in the first five years of some £119,000, but to understand how this came about it is necessary to analyse the moves initiated by the Duke of Argyll to sell the idea of the College, both to his colleagues on the Council of India and later to the House of Commons. These moves must be considered from the perspective of his powers and responsibilities within the Indian administrative system.

The account which follows is based largely on three main sources. Firstly, the official Despatches passing between the Duke of Argyll and the Government of India (many of which are reproduced in Parliamentary Papers); secondly, the official and private papers of the Duke of Argyll in his capacity as Secretary of State for India*; and thirdly, on the Minutes of the Council of India, of which the Duke was President. The record as derived from these and other sources which have been consulted is admittedly incomplete, since, for a full understanding of some of the events which occurred, it would be necessary to carry out a detailed study of the power and patronage exercised by the Duke of Argyll as Secretary of State for India. Such a study lies beyond the scope of this thesis but what follows enables the principal events leading to the

* The 'Papers of the 8th Duke of Argyll' as Secretary of State for India from 1868 to 1874 were photographed by D.L.West (in 1955) by permission of the 11th Duke of Argyll. The originals are housed at Inverary Castle but will not be on 'open access' until 1980. However, West's micro-film series (Reel Numbers 311 to 324) is available at the India Office, London. The bulk of the correspondence relating to the establishment of the R.I.E.C. is contained on reel no.324 and hereafter documents referred to simply as "Argyll Papers" relate specifically to that reel. All other correspondence referred to within the "Argyll Papers" will give the appropriate reel number.
establishment of the College to be understood at least in terms of the public and the semi-official pronouncements of the main protagonists.

**Indian Administrative System**

When the East India Company was abolished in 1858, the enactment which transferred the Government of India to the Crown, Act 106 of 1858, vested all the powers of the company and those which had been exercised by the Board of Control in a Secretary of State. The 'Council of India' with its seat in London was created by the same enactment for aiding and advising the Secretary of State, and its members were to be appointed for life in order to give them that degree of independence in the discharge of their duties which judges enjoyed. The Council of India was to consist of not more than fifteen and not fewer than ten members of whom at least nine must have served or resided in India for ten years.

At the head of the Government in India was placed a Governor General styled also Viceroy, as a representative of the Sovereign. The Governor General also had an executive council, composed of six members and this grouping was known as the 'Government of India' in which was vested the supreme local authority, civil and military, including control over all the local governments. The Government of India had its seat at Calcutta during the cold season, from November to April, and then migrated to Simla in the Punjab Hills for the rest of the year.

Section XLI of Act 106 of 1858 provided that no grant or appropriation of any part of the revenues of India should be made without the concurrence of a majority of votes at a meeting of the Council of India. Sections XXIV and XXV of the same Act provided that every order or communication proposed
to be sent to India should previously be submitted to the Council and that if the majority of the Council were against the act, and the order did not involve any expenditure of Indian revenue, the Secretary of State, should, if he did not defer to the opinions of the majority, record his reasons for acting in opposition thereto.

However, the degree of independence which Parliament conferred on the Council of India, when it provided for its members being appointed for life, was constrained severely by the Government of India Amendment Act of 1869 which provided for vacancies on the Council of India to be filled by the nomination of the Secretary of State for India, and that such appointments were to be for a period of ten years (renewable for a further five years in exceptional circumstances). Hence it would be erroneous to interpret the office of Secretary of State in Council as simply being primus inter pares, rather, the Secretary of State (depending upon the incumbents interpretation of his role) enjoyed almost autocratic powers vis-a-vis the other council members. Thus he had the sole right of bringing any fresh line of action before the Council and the choice of methods for submitting it. He was empowered to summon the Council at any time with as much or as little notice as he should see fit, provided at least one meeting was held each week. He had two votes in the Council. Further, he appointed the Auditor of Indian finances, a power which Robert Lowe as Chancellor of the Exchequer much resented because the Secretary of State was entrusted with the expenditure of vast sums; there was no Treasury to reckon with; those who contributed the money were at a distance and could not control him. In these circumstances Lowe thought that the only possible check was to have a strict and impartial audit.
Clearly as the Secretary of State alone was responsible to Parliament for the conduct of the Indian Administration he was the final authority even where matters of finance were concerned. Thus the incumbent (Northcote) wrote of his Council in 1867, "I should like to have their support ... in anything I may propose, though I should not scruple to act on my own judgement, if necessary". 25 Equally the incumbent in 1869 (Argyll) argued that the Secretary of State was "practically supreme in all matters, whether they do or do not cost money". 26

Similarly although the relative positions of the Secretary of State for India in Council and the 'Government of India' were not precisely defined in statute law, the principle upon which India was ruled from home was stated by the Secretary of State for India (Argyll) on the 24th November 1870 as:

"That principle is that the final control and direction of the affairs of India rest with the Home Government and not with the Authorities appointed and established by the Crown, under Parliamentary enactment in India itself. The Government established in India is (from the nature of the case) subordinate to the Imperial Government at Home. And no Government can be subordinate unless it is within the power of the superior Government to order what is to be done or left undone ... Neither can I admit that it makes any real difference in the case, if the directions issued by the Imperial Government relate to what may be termed legislative as distinguished from executive affairs. It may be quite as essential in order to carry into effect the views of the Imperial Government as to the well being of Her Majesty's Indian Dominions, that a certain act described in common language as executive should be performed". 27

This despatch from Argyll to the Governor General of India (Lord Mayo) leaves no doubt as to the Duke of Argyll's interpretation of the Government of India's function in legislative and executive matters. Moreover, although the Secretary of State himself remained accountable to Parliament, this accountability was seldom enforced as Parliament displayed a general reluctance to discuss Indian affairs when they involved no party question
or home interest. Indeed the annual statements of the Revenue and Expenditure of India were rarely given detailed examination in Parliament.

From the 9th December 1868 to the 20th February 1874 the person charged with this vast responsibility for an area of some 860,000 square miles, and a population of approximately 196 million people, with a total revenue and expenditure in 1870 of £50.90 million and £50.78 million respectively, was George Douglas Campbell, the VIIth Duke of Argyll. Hence he was in control of affairs at the time of the establishment of the R.I.E.C.

George John Douglas Campbell, the second son of the seventh Duke of Argyll was born on the 30th April 1823 at Ardencaple Castle, Dumbartonshire, where he was brought up and privately educated. Of his private tutors he later recalled that they were all young men prepared or preparing themselves for the Ministry of the Established Church of Scotland. As a boy he was an "omnivorous reader" and was greatly interested in science especially chemistry and mechanics. He also developed an acute interest in Natural History (especially Ornithology) which he attributed to a hand telescope his father had given him. At the age of 14 he became Marquis of Lorne and heir to the Dukedom (by the death of his elder brother John Henry in 1837), succeeding his father in April 1847. As a convinced free-trader he took his seat in the House of Lords among the Peelites, and gave an independent support to the Russel ministry.

Although he spoke regretfully of never having enjoyed the discipline of public school or university he quickly established a reputation as a writer on scientific subjects and in January 1851 he was elected F.R.S. In the same year he was elected Chancellor of St. Andrews University, followed by
Lord Rector of Glasgow University in 1854 and President of the Royal Society of Edinburgh in 1861.

He was a frequent speaker in the House of Lords and sat as Lord Privy Seal (1852), Postmaster General (1855) and when Palmerston's Government fell in 1858 and was succeeded by the Derby administration he reverted to the post of privy seal. His administrative abilities were much admired by Gladstone and when the Derby-Disraeli government fell in 1868 and Gladstone formed his first Administration, the Duke became Secretary of State for India remaining in that office until Gladstone's Government fell in 1874.31

Because of the Duke's passionate interest in scientific affairs, the idea, mooted by Chesney, of the State assuming responsibility for the education and training of civil engineers destined for the I.P.W.D. fell on receptive ears. Indeed the Duke later observed that although there was "much yet to be considered about the whole matter - I cannot say I have much doubt about the general principles of the scheme".32

On the 5th March 1869 the Duke of Argyll canvassed the opinions of the Members of the Council of India by circulating Chesney's scheme and noting "it is clear that the present system is quite insufficient. I request the opinions of the Members of Council upon the subject".33 The following were the Members of the Council of India:–

Vice President - Henry T. Princep, Esq.
Members - Sir James Weir-Hogg, Esq.
Elliot Macnaghton, Esq.
Ross D. Mangles, Esq.
Sir Henry C. Montgomery Bart.
Sir Frederick Currie Bart.
Lieutenant-General Sir Robert J.H. Vivian K.C.B.
William U. Arbuthnot, Esq.
Sir Thomas Erskine Perry, K.T.
Of the fifteen Council Members only five were unequivocal in their support for the scheme, Sir H. Rawlinson declaring "I entirely approve of the principle". Central to the arguments in favour of State involvement in professional civil engineering education were the fact that public works in India were to be carried out on a scale of unprecedented magnitude and it was essential that "the construction will be of an endurable character and creditable to British rule". Equally important were, the dissatisfaction generated by both the inferior quality and quantity of the engineers selected in the open market, together with the clear need for a greater cohesion and esprit de corps within the I.P.W.D. "which a methodical education given to the candidates as a body would impart to it".

Thus Sir George Clark noted that "it is prudent to secure for the service of the Government of India, without much loss of time, such an establishment of real engineers" as that proposed, whilst General Baker (later to become one of the scheme's most influential supporters) observed that, "there can I think be no doubt that the prospect of continued activity in the prosecution of public works in India is sufficiently certain and definite to warrant the creation of such a service in addition to the greatest development of the Corps of Royal Engineers".

The other two Council Members in favour of the scheme were
Sir R. Vivian who considered "establishing a College for the education and training for public service of civil engineers well calculated to meet the ever increasing requirements of the I.P.W.D.", and Sir R. Montgomery who thought "the plan proposed by Colonel Chesney will meet what is required" and the College training should be "both professional and practical".

Although two-thirds of the Council Members did not support the proposal, one member (Perry) did "not feel competent to offer an opinion of any value on this subject", whilst another (Hogg) wanted further information but was not convinced of the "expediency of establishing a College for Engineers".

The remaining eight Members provided a wide variety of reasons for rejecting the scheme. Ross Mangles agreed that "it cannot be doubted that for the many important works that lie before us in India there is a great want of highly qualified and trustworthy engineers, and that the economy, in various ways, which would result from having a choice of such men available for employment in the planning and executing works of that nature, would abundantly compensate the Government for any reasonable cost that they might have incurred in training the fitting instruments for their purposes". However, he was more impressed by the need for "esprit de corps" and observed the "lax moral principles" of many civil engineers who had a bad habit of "running in couples" with contractors. Consequently he argued that "the machinery for education and training, and that of the highest order, is already available at Woolwich and Chatham. Why then should it be necessary to establish a separate college to educate engineers for India?"

By comparison, "the establishment of a college for the exclusive instruction of our own engineers does not recommend itself to my judgement" declared Elliot Macnaghton, who proceeded to
recommend a revival of the 'old system' of offering the appointments in the I.P.W.D. for competition to the cadets of Sandhurst and Woolwich; "and the successful candidates might be sent to Chatham as they formerly were from Addiscombe, there to undergo an engineer training".\textsuperscript{46} Similarly the idea of reviving Haileybury was embraced by Henry Princep who thought "that it was a great mistake to abolish the Haileybury Institution. Open competition might have been established instead of patronage and nomination as the rule for entering the College".\textsuperscript{47}

Equally, Chesney's scheme was regarded by Sir H. Montgomery as "a revival of Addiscombe without the military element of that excellent institution, the discontinance of which is now so keenly felt".\textsuperscript{48} Nevertheless he considered the time not yet ripe for abandoning the principle of open competition "as the surest and best means of providing servants for the State of every class". On the other hand, Sir F. Currie doubted the necessity for establishing a separate college and argued that "some other arrangement might be made with some existing institution".\textsuperscript{49}

Although Sir F. Halliday's views were not yet finalised he nevertheless called for "an expansion of the Corps of Military Engineers and at the same time a freer selection from the great body of civil engineers in this country"\textsuperscript{50} - a sentiment not entirely espoused by William Arbuthnot who regarded military engineers in India as "birds of passage" with no certainty of continuous employment in the I.P.W.D. Moreover, Arbuthnot would not commit himself to the proposed scheme until he had an estimate of the probable expense involved and meanwhile urged consultation with "some of our most eminent civil engineers as they might perhaps be able to suggest a scheme as efficient and
less expensive than the establishment of a College of our own. 5

By far the most penetrating analysis of the proposal was submitted by Bartle Frere who began with the basic assumption that "if the present supply of engineers is insufficient and cannot be increased by merely calling for more, it is clear that Government must begin to educate engineers on its own accord". 52 However, Frere noted the danger of Chesney's scheme "is that in creating this esprit de corps we do not fossilize the profession", by separating "Colonel Chesney's corps of civil engineers" from the rest of the civil engineering profession. "If for no other reason, in order to prevent an ex-Government engineer from being of necessity a ruined man if obliged to leave the India service before he has earned his pension". Moreover Frere noted that Chesney's scheme could be of great advantage to the profession generally but it would have a contrary effect if failure as a Government engineer became synonymous with professional failure generally.

"For these and other reasons it seems to me essential, that any scheme devised shall fit into existing institutions such as the Universities and Engineering Colleges in the three Kingdoms". 53 In addition, Frere identified a possible source of opposition in that "Colonel Chesney's scheme seems to contemplate throwing these existing engineering colleges and schools altogether overboard, but apart from considerations of justice it seems to me that we can hardly expect institutions like the Irish and Cheltenham Colleges and others which have for years laid themselves out to train for the profession, should submit to be thrown overboard or fail to give much trouble in their efforts to secure justice".

Furthermore, "the men we want could not be collected and kept at any one Institution near London except in one of two
conditions. Either we must take them exclusively from the wealthier classes who, to serve a good and certain profession, will pay almost the whole expense of a rather costly course of instruction, or Government must pay a great portion of that expense and the cost will be no trifle.\(^{54}\)

In consequence Frere advocated the establishment of a Committee of Inquiry composed of distinguished civil engineers in England as well as those who had practical experience as civil engineers in India, and charged to take evidence and give the Secretary of State "a scheme for training Government engineers for India so as not to unfit the men so educated for civil engineering work in other parts of the world".

Two outstanding features of the soundings thus received from the Council Members were (a) that the Council of India was used as a forum for the exchange of views between the Members and the Secretary of State prior to the initiation of a new line of action, and (b) the relative absence of any cost consciousness with only four members expressing concern at the possible expense involved (viz. Arbuthnot, Currie, Frere and Princep). In this context it is significant that a perusal of the annual tables of Indian Revenue and Expenditure for the period 1860-1869 (inclusive) reveals a deficit of income in seven out of the ten years amounting to approximately £3 million per annum. Clearly with a total expenditure on public works for 1869-1870 estimated to be some £7 million and the possibility of the State funding extraordinary public works (from loan capital) the relative cost-benefit was not far from the Duke of Argyll's mind. Indeed faced with such a diversity of opinion amongst his colleagues on the Council of India, the majority of whom were clearly not predisposed to Chesney's scheme, the Duke requested an estimate of the likely expense involved in the
proposal. However, as Chesney had returned to India in the beginning of May, the following estimates were drawn up (on the assumption that 50 engineers would be required annually) by Dr. Wrigley and submitted to the Duke of Argyll on the 7th June 1869.

One Principal at £1,000
Four Professors at £500
Thirteen Masters at £300
One Assistant Master at £200

Total £7,100

Cost of boarding 150 students at £50 each £7,500
Rent of suitable building for College £3,000

£17,600

From the total thus obtained was to be deducted £15,750 on account of the annual payment of 100 guineas proposed (by both Wrigley and Chesney) to be paid by each student. The net expense, annually, was therefore anticipated at £1,850 which divided by 50 gives the expense per head to the Indian Government - since the cost of the College would have to be borne out of Indian finance - of £37, for having engineers specially trained for the Indian service. Moreover, within the above estimates a system of 'payments by results' was proposed so that "the remuneration of the educational staff should rise and fall with the success of the College". In consequence, a half or two-thirds of the above salaries should be regarded as fixed, the rest was to be made up by capitation payments in respect of individual students. One hundred and fifty students were needed to bring the salary up to the maximum amount proposed.

From the receipt of this estimate of the probable cost involved, events began to move rapidly, and, at the next open competitive examination on the 5th July 1869, fifty candidates
applied for forty appointments of whom only twenty passed the minimum qualifying test. The Duke of Argyll must have viewed this result as further and opportune testimony to the sagacity of Chesney's proposal.

The Argyll Papers contain a letter from Major-General Baker to the Under-Secretary of State for India, Mr. Grant-Duff, dated 23rd August 1869, in which Baker alludes to a letter sent by Argyll to Grant-Duff. Baker says, "I return with thanks the Duke of Argyll's letter about the Civil Engineering College and am glad to hear that he is disposed to commence at once on its organization".57

The letter also shows that General Baker had been invited by the Duke of Argyll to comment on the choice of a possible Principal and to consider whether he ought to be a military man or a civilian. Not surprisingly Baker favoured the former because the infusion of a "military esprit de corps into our civil section will tend to the homogeneity of the Department as well as to raise its tone. I believe also that an experienced military man would maintain discipline in such an establishment not only on a better system but also more easily than a civilian".58 Consequently Baker recommended three officers for consideration: Colonel Maclagan who was the first Principal of (and in fact arranged) the Thomason College at Roorkee; Major Chesney who also had experience at Roorkee and "on whose suggestion we are now acting in regard to the new institution",59 but if there were any objections to bringing either of these officers home from India, he proposed Sir F. Abbott "many years Governor of our Addiscombe College and highly qualified by temper, tact and sound character for the direction of such an establishment as we now propose".60

Having thus reached a decision to establish an engineering
College, it now remained for the Duke of Argyll as the 'prime mover' to bring the matter formally before the Council of India for ratification, as it was clearly necessary to forward a despatch to the Government of India informing them of the new arrangements for supplying the I.P.W.D. with civil engineers. Accordingly a draft despatch was laid before the Council on the 18th November 1869 and the following week, after long discussion, an amended draft was approved by eight votes to three.

In this Despatch the Duke declared that the idea of establishing a College for training civil engineers for the I.P.W.D. had occupied much of his attention. He also observed that "as to the general expediency of such a measure, I have no doubt of having the full concurrence of your Government who are only too well aware how unsatisfactory the arrangements to be superseded by it have hitherto proved, and how still more inadequate to their intended purpose they would become now that the number of recruits required for your engineering establishments is likely to be largely increased".

The Duke also emphasised that three points were already decided, namely, "that there shall be a College; that admission into it shall be obtainable by competitive examination, or by some system which shall prove an effectual guarantee for the general fitness of the candidate, and that whoever may obtain admission shall, on condition of passing prescribed tests after completion of the College course, be assured of an appointment in the I.P.W.D.". Similarly he declared his intention to create greater harmony in the I.P.W.D. by offering equal inducements to both the military and the civil branches of the service.

However, as the success of the College would largely
depend on the character of its Principal, Argyll noted, "from what I have seen and heard, however, of Major Chesney, R.E. ... I believe it would not be easy to find anyone better qualified for this particular post, and I am desirous, if you are willing to spare his services, that the appointment should be at once offered to him, for a period of five years on a salary of £1,000 a year ... with a residence". Although these factors were decided upon and enclosed in the Public Works Despatch No. 119 of 30 November 1869, it is interesting to reflect on the comments of members of the Council of India appended to the draft despatch.

One anonymous member declared "I am opposed to establishing a College for engineers. I think it unnecessary and the expense would be very great. If the number required and the advantages of the service were made known we should have no difficulty in getting competent men". Similarly a conflict of opinion between the Duke of Argyll and General Baker on the matter of pay was evident. On the one hand Argyll held that the service would lack "one of the main attractions from which we hope for success" if the civil members who were performing precisely the same duties as military engineers were nevertheless rewarded with inferior pay. On the other hand Baker held that the proposed equalization of pay could not be confined to the alumni of the future college but must "extend to the non-military men already employed in the I.P.W.D.".

In these circumstances if the proposed equalization was to be achieved without incurring any increase in expenses "the civil element being much larger than the military the loss of each individual military officer must be much greater than the gain to each civil officer". Indeed Baker argued that if this occurred the military officer would be placed in an inferior
position to the civil engineers because of the former's liability for military service. In the event however, the issue was resolved upon the receipt of a notification from the Government of India, dated the 6th October 1869, which followed the "Simla Calumy" of 31st August, and proposed the equalization of salaries.

The Government of India faced with the fait accompli in the Public Works Despatch No. 119, replied on the 28th March 1870 expressing considerable doubt as to the necessity for establishing a College. Indeed they considered "the success of such a College to be a matter of very great uncertainty, that it must be regarded entirely as an experiment, and that we have great doubts that any real necessity exists for its immediate establishment". The Government of India regarded estimates of future requirements as extremely vague and "of a very fellacious character" because experience had shown a volatile pattern of recruitment to the I.P.W.D. Hence, "a College might now be started, it might very possibly be found that, in a few years, the demand for engineers had so increased that it could not be met by any expansion of the College which might be immediately practicable".

In contrast, the Government of India favoured increasing the emoluments to attract more highly qualified candidates to service in the I.P.W.D., and one Government member called for the opening of the Royal Academy at Woolwich to candidates for the I.P.W.D. However, their strongest criticism was directed at the financial commitment of the Government of India as, "the Institution in short would, in our judgement, be distinctly condemned if it could not be conducted on what would be an entirely self-supporting basis". Thus the Government of India acquiesced to the Secretary of State's decision to
establish a College, and, with regard to the appointment of Colonel Chesney as the first Principal they noted that "his removal from his present office will be a serious loss to the Government, and one which will not easily be replaced". Nevertheless they could not object to him improving his position "as he considers that he will do by accepting the offer made to him by your Grace". In consequence Chesney returned home in April 1870 and from that time until the 19th July 1870 he was, under the direct orders of the Duke of Argyll, engaged in various preliminary enquiries the results of which will be elaborated later in this chapter.

In reply a draft despatch to the Government of India was drawn up and placed before the Council of India on the 30th June 1870 and ordered to lie for consideration. In this despatch Argyll declared that he was not prepared for so much difference of opinion but he emphatically rejected the suggested increase in salaries as a panacea, and observed that "merely to offer augmented emoluments to candidates who could manage to pass certain prescribed tests would, it is to be feared, have little better effect than that of bringing forward imperfectly trained candidates in greater numbers than before, and of introducing into the I.P.W.D. a proportionately increased number of imperfectly qualified officers, to commence, too, on salaries nearly twice as high as at present". He also rejected the suggested Woolwich scheme because three out of the five years course was devoted to military studies which would have little direct bearing on the business of a civil engineer. Moreover, on the need for a self-financing establishment the Duke declared that "no care shall be spared to render the Institution as nearly as possible self-supporting" but in any event the annual loss was calculated not to exceed £2,000.
Hence the Duke observed, "I retain, therefore, my original opinion as to the expediency, and indeed necessity, for establishing a College".

Almost three weeks later, on Tuesday 19th July 1870, the Council of India after long discussion voted on this despatch, the 'ayes' carrying the day by six votes to five. Of the eleven members present (the Duke of Argyll presiding) the following were those in favour of the proposal: Arbuthnot, Baker, Frere, R. Montgomery, Rawlinson and Vivian, whereas the following members remained dissentient: Clark, Hogg, Macnaghton, Perry and Princep. Finally it is noteworthy that of the four absent members (Currie, Halliday, Mangles and H. Montgomery) all had expressed opinions unfavourable to the scheme when opinions were first canvassed in March 1869.

Having thus squeezed through in a final ratification by the Council of India it was resolved two days later on the 21st July 1870 that Colonel Chesney be appointed Principal of the Civil Engineering College (his appointment being backdated to the 24th April 1870) for a period of "seven years, with power of re-appointment, and the salary of £1,000 p.a. exclusive of his military pay proper and a residence".74
Institutional and Personal reactions to the notion of State involvement in professional Civil engineering education.

The decision to establish an Engineering College in England, which was finally ratified by the Council of India by a majority of one vote on the 19th July 1870, was not formally announced in Parliament until the following month. However, within the press a rumour to the effect that a new Civil Engineering College was about to be launched had been circulating for some time. Thus, a correspondent of the journal "Engineering", (which had a marked editorial policy in favour of systematic engineering education), noted in June 1870, that the scheme had "been for some time incubating and is now nearly hatched". In the previous month, the same journal observed in a Leading Article that the competitive examination system had not worked but that differences of opinion existed on the cause of the failure. Further, considering the numbers of students "who are studying at the engineering classes of our schools and colleges and those serving pupilage, it cannot be that qualified persons do not exist in sufficient numbers ... to admit as much would be broadly to condemn that system of professional education by which many of our leading, and most of the rising men amongst civil engineers of the present day have been trained; a contrary assertion would appear to point to some defect in the system of selection, or to a want of sufficient liberality in the terms of engagement offered to induce really good men". In consequence, "Engineering" deduced that the Secretary of State for India either thought that the system of education in this country was defective, or that a competitive examination was not the best means for testing the capabilities of an engineer.

Clearly the evidence presented by Chesney and supported by the Duke of Argyll placed overwhelming emphasis on the
defective nature of the existing system of civil engineering education. By rejecting the suggested salary increase, even for an experimental period, the Duke left little doubt as to his view of the nature of the defects in the existing open market system. Indeed it could be argued that this rejection constitutes a basic indictment of the pupilage system and of the existing Schools and Colleges concerned with civil engineering education. It was not unreasonable, therefore, to anticipate vigorous opposition from those with a vested interest in maintaining the status quo, particularly from those it was contemplated to "throw altogether overboard", viz. the Schools and Colleges.

By August 1870 the University of Glasgow considered its interests sufficiently impaired to warrant the despatch of duplicate letters to its Rector (the Duke of Montrose) and Chancellor (Lord Derby) declaring that, "the Senate conceive that if the proposed Government College were to have a monopoly of the supply of candidates for the I.P.W.D., a serious injury would be done, not only to those Universities which embrace civil engineering as a Department of Study, but to the public service by narrowing the field for candidates". Indeed the Senate of Glasgow University appointed the Head of the Department of Civil Engineering and Mechanics, Professor Rankine, as a convenor of a committee to consider the subject and ascertain the Government's intentions, particularly whether it was intended to exclude all candidates except those educated "at the proposed Government College".

However, Government's intentions were not to be sounded quite so readily and in response to an enquiry from Professor Rankine, the Duke of Argyll stated that the arrangements for the new Civil Engineering College for India were not as yet
completed, but that as soon as they were sufficiently matured, full information in respect of them would be given to the public. As the University of Glasgow was not to be informed until complete arrangements had been made the Senate of that University then urged their Rector and Chancellor to consider whether anything could be done in Parliament or elsewhere, to obviate the possible evils which would arise from the apprehended monopoly.

In a letter to the Duke of Argyll dated 5th August 1870, Lord Derby emphasised the strong prima facie case in "the apprehended monopoly" and in a private note the following day Argyll replied: "I am of course interested, as you are, both personally and by the offices I hold in connection with the Scotch Universities in their welfare; and I should wish to do everything I could to avoid interfering with any of the inducements they may hold out to their students". However, the Duke declared his paramount duty to India and in particular to ensure that its Government was supplied with the best possible candidates for the I.P.W.D. In forcibly stating the defects of the existing system he noted that the minimum pass mark under the open competitive system had been continually reduced so that the Government had been sending out the "merest trash". Because the existing means of education, whether at Schools or at Colleges and Universities, "do not give us what we want", Argyll considered it reasonable that Government should intervene to provide an adequate flow of properly trained men for the I.P.W.D. However, he conceived of no monopoly except "the monopoly of fitness as tested by open competition among those who are to enter the College for a special education not now afforded elsewhere - as we have found by experience". Motivated by this response, the Principal of Glasgow University (F. Barclay, D.D.) submitted a formal Memorial against the
establishment of the Indian Civil Engineering College on the 13th August 1870.83

A similar Memorial was submitted on behalf of the Provost and Senior Fellows of the University of Dublin which asserted that "the School of Engineering was established in the University of Dublin in 1842 with the view of combining the theoretical and practical instruction requisite for the profession of civil engineering, and at the same time, of imparting to the member of that profession the advantages of an academical education".84 The memorial further observed that 279 licences to practice engineering had been issued since that time. Indeed when the open competitive system for entry to the I.P.W.D. was first instituted, (in 1859), the requirement that candidates "must have passed not less than three years as articled pupils to a civil engineer" was considered so prejudicial to the interests of the University of Dublin that a Deputation was sent to London to wait on the Secretary of State for India to indicate the hardship imposed by that condition.85 It was subsequently agreed that "gentlemen holding Diplomas of recognised schools of engineering shall be permitted to compete; such diplomas guaranteeing a course of at least two years of engineering studies provided that they furnish also satisfactory evidence of having served an additional year with a civil engineer in practice".86 In the same way, the establishment of a Government Engineering College was considered equally prejudicial to the interests of the University of Dublin, and of kindred Institutions. Consequently the Memorial deprecated the proposed exclusion from the engineer service of India of the Licentiates of the Universities, and also urged that such Universities "afford not only the means of obtaining the theoretical and practical instruction requisite
for the profession of civil engineering, so far as such
instruction can be furnished by any college, but that these
Schools admit of their members obtaining, at the same time,
the advantages of an academical education".87

By mid-November 1870 formal Memorials against the
establishment of an Indian Civil Engineering College, were
received from the following Institutions:88

- The University of Glasgow 13th August 1870
- The Union of Lancashire and Cheshire Institutes 28th October 1870
- The University of Dublin 8th November 1870
- Queen's College Cork 9th November 1870

Indeed the Memorial on behalf of the Union of Lancashire and
Cheshire Institutes called for the establishment of an
examination in civil engineering under the auspices of the
Department of Science and Art. They also urged Government to
give primary assistance to the engineering schools which
already existed and to encourage the establishment of others
in the principal Manufacturing Districts "recognising by
payment the results obtained in any educational Institution".89
In this way a healthy emulation would be excited all over the
country and students would be instructed "at less expense than
by our central Government establishment which would only contain
a small proportion of the actually available students". The
Memorialists further observed that in such local establishments
the Government could utilize the talents of the best Military
engineers by allowing them to be used as professors and
Teachers to the mutual benefit of the officers and the Country.

However, an analysis of the "open market system" reveals
that in the twelve year period 1859-1870, 319 appointments were
offered to competition; 195 candidates were appointed in this
way leaving 124 appointments unfilled. In the first two years
no records were kept of the places where the candidates were
educated but in the next ten years 173 competitors were accepted of whom 86 were partially educated at a school or College with an engineering department. Of the 86 the following numbers were educated at:

- King's College, London - 17
- Dollar Institution - 16
- Trinity College, Dublin - 14
- Queen's College, Cork - 13
- Queen's College, Belfast - 7
- Queen's College, Galway - 6
- Mr. Riggs School, Chester - 5
- Madras College, St. Andrews - 4
- Glasgow University - 3
- Aberdeen University - 1

Placed in this context the Memorial from Glasgow University could be treated with derision for as Chesney noted "if its engineering faculty depends on the results of its training for the Indian Service it must indeed be in a critical state". Similarly the University of Dublin and Queen's College Cork in providing 14 and 13 (respectively) successful candidates in ten years did not inspire confidence, and Chesney observed caustically that "India has been sacrificed, to encourage half a dozen so-called engineering schools to go on turning out ill-prepared students".

Nevertheless, the principle of Government endowment of a civil engineering College, with a built-in monopoly to supply engineers to the I.P.W.D., soon aroused open hostility. Government's intention to establish such an engineering College was formally announced in the House of Commons on Tuesday, the 9th August 1870, and the following day Parliament rose for the winter recess (until the 9th February 1871). However the Member for Brighton, Henry Faucett, M.P., was deeply interested in Indian finances and the gravity of the proposal moved him to write on the 12th August to the Secretary of State...
for India warning him against proceeding with the suggested engineering college. Thus, "I think it is only fair to tell you that should any outlay be incurred for the College before the meeting of Parliament, I shall feel it my duty to ask the House with the least delay possible, to express its disapproval of the proceedings". 94

With the matter likely to be raised in debate on the floor of the House of Commons, the Duke of Argyll did not feel justified in proceeding until the views of senior members of Parliament were ascertained, and, to this end, he wrote to the Prime Minister enclosing Fawcett's letter. In reply Mr. Gladstone noted, "... I own however that I am far from feeling clear about your plan of a Government College (if I understand it right) in England for training civil engineers for India. To test any misgivings I referred to Granville, who I find shares them". 95 Further, "I do not in the least embrace Fawcett's principle. I am fearful of the Parliamentary opposition to a measure for educating civil engineers in this country out of public (Indian) funds". To avoid such opposition Gladstone suggested establishing prizes, scholarships or other rewards in connection with the prospect of employment in India at one or more of the establishments already existing. However, should Argyll continue with the proposed College, he was confident that Argyll would not carry it without the support of eminent persons outside the India office and the Government. "Perhaps you have tested your ground and have ascertained that such support would be forthcoming".

Clearly the ground had not proved especially fertile when, in March 1869, the Duke had first consulted his colleagues on the Council of India; and again when the decision to establish the Civil Engineering College was finally ratified in July 1870
the decision was barely carried. On such barren soil the scheme could not possibly have reached fruition without, as a minimum requirement, the total commitment of the Duke of Argyll (supported by the continued exhortations of Chesney).

Of the eminent politicians and Statesmen consulted, Lord Halifax (formerly Sir Charles Wood) writing from Balmoral Castle on the 25th August observed, "I agree with Gladstone in thinking the proposal more than doubtful". However, after considering the issue in greater detail and the opposition likely to be generated from other sources, particularly the Institution of Civil Engineers, Halifax noted, "You might say to the Civil Engineers - you don't supply us with the requisite number of adequately instructed men - improve your education and educate your members. If you do that and supply what we want we will take your men, and the field is large in India".

By the end of August 1870 the Duke of Argyll directed that the entire scheme be held in abeyance pending a review of the likely opposition, from all quarters, and the suggested counter arguments to such opposition. On receiving this news Chesney wrote "I need not say that it was a very great disappointment to learn that the process of establishing the College was to be suspended just as the arrangements for it had reached the point of completion". However he addressed himself to the problem in hand and provided Argyll with an analysis of the opposition to be anticipated from four quarters, viz. The Royal Engineers, the Government of India, the Civil Engineers, and the Schools and Colleges.

The possibility that the Royal Engineers in India might sense an encroachment on their traditional preserve was rejected by Colonel Chesney who argued, "the corps as a body is quite
aware that it must not attempt to monopolise the whole Indian Engineer Service and is moreover ... quite satisfied to have a reasonable share in this field of employment". He further asserted confidently that both the Civil and Military members of the P.W.D. in India were strongly in favour of the establishment of the College. With regard to the Government of India, Chesney, speaking from personal communications with several of its Members, declared that its opposition arose chiefly from pique at not having been consulted. However, among the military engineers of the P.W.D., whose views on the subject would probably have preponderating weight with the Government, the feeling in favour of the College "is almost universal".

To counteract possible opposition from the civil engineers Chesney argued that part of the third year of the College course should be spent as a pupil of a civil engineer. In this way a certain number of the best engineers would be connected with the College by co-operating in the training of students. "I have always looked to this feature of the new system as an important element towards carrying the profession with us"; he declared. Nevertheless, despite such provision, "there will remain of course a selection of the old school of engineers, of the rule of thumb sort, who view with distaste any change to a more methodical system of educating men for the profession other than that they were brought up under". In this context it is significant that at the time of the "Simla Calumny" and the subsequent meetings between the Duke of Argyll and the President and Members of the Council of the Institution of Civil Engineers, the proposed College was not discussed.

In the case of the Schools and Colleges the issue was not
so straightforward as it was clearly intended to abandon them altogether. Consequently Chesney argued that the present dilemma was entirely of their own making; "they have had the matter in their hands for the last eleven years and have thrown away the opportunity afforded them". Moreover Chesney was unimpressed by any appeals from the Schools and Colleges, and argued conversely that the list of Schools and Colleges recognised by the Secretary of State as possessing efficient classes for instruction in civil engineering was most imperfect, and indeed that some of those listed were "quite unworthy of the name". He held that the number of passed students from these Institutions did not indicate an excessively fertile seed bed for future candidates for the I.P.W.D., but in the final analysis he observed that the opposition from this quarter "is after all, not serious, it is certainly very much less than I fully expected would be aroused". In fact at the time of writing this memorandum the only formal Memorial, against the establishment of the College, that had been received was that from the University of Glasgow. Hence the Duke of Argyll was urged to continue with the proposed College and stifle all such opposition "once the thing is done".

A similar memorandum was prepared by the Secretary of the Public Works Department, W.G. Thornton, who argued that "as to the Heads of Colleges and Schools interested in preventing the creation of a rival Institution, not only is their bark very much worse than their bite, but their bark itself is effective chiefly by reason of its faintness of tone. If they would only make noise enough in the Newspapers we should have expected for meeting them vigorously in the same quarter, but to commence a newspaper controversy without more worthy antagonists would be like beating the air, and we should seem to be accusing
ourselves by the pains we took to reply to charges made by nobody worth listening to". 102

The Duke of Argyll was sufficiently impressed with Chesney's evaluation of the possible opposition to the scheme, that he discussed Chesney's paper with Mr. Gladstone. However, the Prime Minister remained unmoved and indeed stated, "I do not think Colonel Chesney at all full and conclusive (at least for persons so ill informed as myself) in the negative part of his argument where he has to show that the end in view cannot be gained through stimulus or aid to existing Institutions. All I know is that this is a very critical subject and that voluntary Institutions in kindred subjects feel exceedingly the tax paid competition of the Government". 103

Mr. Gladstone's remarks were plainly displeasing to the Duke of Argyll but he remained undaunted in his support for the scheme. Moreover, he informed Gladstone "that if we are to wait till some new born scheme for scientific education in England is to be squabbled over and settled, we may wait for an indefinite time". 104 Nevertheless until the Prime Minister's criticism could be allayed he clearly felt some anxiety in proceeding.

In assessing Gladstone's caution, Argyll identified a way of blunting Parliamentary opposition, led by Fawcett, and of obviating the Prime Minister's anxieties simultaneously, by placing the Institution on a "self-financing" rather than "tax-paid" basis. However the ability of the scheme to be self-supporting hinged largely on the initial capital expenditure required for a building suitable for a civil engineering College. It was therefore imperative to have more certain data regarding the cost of a site and the necessary fixtures and fittings.
The search for a suitable building for the proposed College.

From the time that Colonel Chesney returned home in April 1870 he was charged with making the necessary preliminary arrangements (drafting a Prospectus, etc.) for the establishment of the Indian Civil Engineering College. In this capacity he was empowered with Sir Digby Wyatt, the Architect, to consider suitable properties for the proposed College and to make recommendations. Altogether five buildings were visited in the summer of 1870, namely, Maidstone Barracks, an hotel at Eastbourne, Oatlands Hotel at Weybridge, the Malvern Hotel and the Barracks at Chichester. Permission could not be obtained to visit a sixth building, the Mansion on the Cooper's Hill Estate at Egham in Surrey, owned by Baron Grant. In consequence both men were allowed to bid simultaneously for Oatlands Hotel and the Malvern Hotel, and it appeared that Oatlands "if to be leased or bought at a reasonable price, appears decidedly the most suitable place for the College of those that have been heard of. Next to it I would put Cooper's Hill, judging from the drawings of the buildings".

A "Public Works Committee Minute" dated 28th July 1870 records that "the Public Works Committee recommend that steps be taken for the purchase of the Oatlands Hotel (Weybridge) for a sum not exceeding £45,000 and that Sir Digby Wyatt be associated with Colonel Chesney to carry out the transaction". However due to a misapprehension, negotiations had to be abandoned as the asking price proved to be £77,000.

On the 3rd October, Chesney had the opportunity to visit the estate at Cooper's Hill and so impressed was he of the buildings suitability that he recommended its immediate purchase. "It is impossible", he declared, "to speak too highly of the general suitability of the place for the proposed
purpose". The estate consisting of 121 acres beautifully situated on the banks of the Thames, with a Mansion upon it, was for sale at £55,000. In Chesney's view Cooper's Hill was the best site and critical factors in favour of its purchase were, its proximity to London, (because of the assistance required from "leading engineers and scientific men"), the undulating ground (invaluable for instructing in Surveying) and the Thames (which was considered "as good as a couple of extra Professors to us"). Moreover, as £20,000 was needed to render the building complete (total cost of £75,000) this represented an annual investment at 4% of £3,000 and clearly 150 students lodged at this expense would get their rooms at £20 each per year.

Chesney's letter to the Duke of Argyll recommending the purchase of the Cooper's Hill Estate was dated the 6th October 1870, and, in his opening remarks he observed, "the place appears so remarkably suitable for the college that it seems a pity not to make an effort to secure it". However, he noted that "even should the College scheme eventually fall through, the worst that would happen would be the having to get rid of the place again, and the risk in this case should be very slight, since there seems no doubt it is worth considerably more than the sum asked, while if the College is to go on, the time is not at all too long for making the needful preparations, while so excellent a chance may not occur again".110

As the property was for sale as being beyond the owner's means to maintain it, Chesney ventured to suggest "that if your Grace is in a position to bring the matter before the Council on return to London, the place should then be secured, as although there is a possibility of the purchase turning out not to be required, the risk to be taken appears small in comparison
with the advantage offered by such a course. The needful preparations could then be set in hand for the required additions, when if all goes well, they could be commenced on early in the Spring and completed by the Summer."\textsuperscript{11\textsuperscript{1}}

Plainly the necessary structural alterations could not be made until the Estate was acquired by the Government, and, if the actual building work was postponed until the issue was finally resolved, Chesney claimed that the saleable value of the property would not be impaired, in the event, of its having to be surrendered.

Prior to submitting this letter Chesney consulted Major General Baker who had been recently Knighted and whose opinion was highly regarded by the Secretary of State. In consequence Chesney wrote "Sir W. Baker ... concurs in strongly recommending this proposal". Indeed by the 12th October 1870 Chesney had received a letter from Baron Grant stating that the owner intended to limit his price to £55,000 "only until the 22nd inst.", but "as there would still be time to bring the matter before the Council by that date Sir W. Baker entirely approves of my referring the matter to your Grace"\textsuperscript{11\textsuperscript{2}}.

At this juncture the sequential order of events is extremely important. Argyll sought the opinion of the Secretary of the Public Works Department (a committed enthusiast of the proposed College) and in his reply dated the 18th October 1870, Thornton noted: "no doubt it can scarcely appear otherwise than premature to spend £50,000 on buildings, etc., for a College before it is certain that a College shall be; but I would ask leave to suggest that the chief ground for doubt on the point may perhaps be the delay in deciding it in the affirmative. It is this apparent hesitation that encourages the larger class of objectors, viz. those who object from
interested motives, and who as soon as they saw that the thing was irrevocably settled, would most likely be wise enough to adapt their educational apparatus to the altered situation without wasting time railing at it".113

Moreover Thornton argued that, "the case for the College is so strong and the want of something of the kind so urgent", that all the opposition could possibly do would be "to delay it a twelve-month hence". In these circumstances the balance of the reduction of price to be obtained by purchasing forthwith had to be set against the possible loss of between £2,000 and £3,000 as "interest for twelve months or so on £50,000". Plainly Thornton argued, "the Indian Government could scarcely have the face to charge the Home Government with extravagance on that amount, considering what sort of things they are continually doing themselves".114

The concerted voices of Chesney, Baker and Thornton in advocating the immediate purchase of Cooper's Hill were to no avail as Sir Digby Wyatt had not yet had an opportunity to inspect the property and submit a formal estimation of its value. Hence although it may have been as Thornton said, "prudent to risk so little for the chance of so much", Argyll would not embark on such a purchase without more certain data.

Meanwhile on the 21st October, Gladstone's letter was received and the project seemed to be clouded with doubt. However by the 27th October Wyatt had inspected the property and in his report substantiated Chesney's estimate of its value. Indeed Wyatt reported that the property "would always maintain its value", that it needed little alteration and could be opened for work within three months, and that it would provide an "attractive academical establishment". In forwarding Wyatt's report to the Duke of Argyll, Chesney found
it "gratifying to find that Sir Digby Wyatt's report is, if anything, stronger than what I have written as to the suitability and cheapness of the place, and his estimate of the cost of alterations does not differ much from my rough one". 116

Upon receipt of Wyatt's report, Argyll acted promptly and within a fortnight the matter was submitted to the Council of India where it was resolved on the 9th November, 117 "that Sir Digby Wyatt and Colonel Chesney be empowered to purchase the Cooper's Hill Estate for a sum not exceeding £55,000". In December the official solicitor was instructed to carry out the arrangements for the purchase of the Estate "in the absence of any reasons in his judgement to the contrary", 118 and Sir Digby Wyatt was authorized to proceed with the necessary plans and working drawings for providing the necessary accommodation at the College, and on the 30th January 1871 the contract to purchase was completed.

The Secretary of State was continually mindful that the College should be self-financing and to this end the following estimation of Establishment Charges was prepared. 119

<table>
<thead>
<tr>
<th>Position</th>
<th>Pay (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>President, in addition to English Military pay of rank</td>
<td>£1,000</td>
</tr>
<tr>
<td>Professor of Civil Engineering</td>
<td>700</td>
</tr>
<tr>
<td>Assistant - Civil Engineering</td>
<td>450</td>
</tr>
<tr>
<td>Professor of Mathematics</td>
<td>600</td>
</tr>
<tr>
<td>Assistant - Mathematics</td>
<td>450</td>
</tr>
<tr>
<td>Professor of Physical Science</td>
<td>600</td>
</tr>
<tr>
<td>Professor of Surveying</td>
<td>600</td>
</tr>
<tr>
<td>Assistant - Surveying</td>
<td>450</td>
</tr>
<tr>
<td>Professor (or Instructor) of Hindustan and History of India</td>
<td>350</td>
</tr>
<tr>
<td>Professor (or Instructor) in Mechanical Drawing</td>
<td>450</td>
</tr>
<tr>
<td>Assistant - in Mechanical Drawing</td>
<td>350</td>
</tr>
<tr>
<td>Professor (or Instructor) in Landscape Drawing</td>
<td>300</td>
</tr>
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</table>

£6,300
127

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowance for additional lectures in Physical Science, Mechanics, Architectures, etc.</td>
<td>500</td>
</tr>
<tr>
<td>Laboratory, Model room and artificers employed thereon</td>
<td>750</td>
</tr>
<tr>
<td>Library</td>
<td>100</td>
</tr>
<tr>
<td>Clerk</td>
<td>150</td>
</tr>
<tr>
<td>Steward, Housekeeper, Porters and other servants</td>
<td>1,200</td>
</tr>
<tr>
<td>Rates, Taxes, fuel and light</td>
<td>900</td>
</tr>
<tr>
<td>Services of Clergyman and sittings in Church</td>
<td>250</td>
</tr>
<tr>
<td>Contingencies</td>
<td>300</td>
</tr>
<tr>
<td>Provisions</td>
<td>4,000</td>
</tr>
<tr>
<td>Fees to engineers for instruction of students on works or workshops</td>
<td>2,500</td>
</tr>
<tr>
<td>Lodging money to students while thus detached</td>
<td>1,200</td>
</tr>
<tr>
<td>Travelling expenses for parties visiting works of interest</td>
<td>200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£ 18,350</strong></td>
</tr>
</tbody>
</table>

Thus, on the assumption that fifty students (with the ability to pay £450 for their education) would enter the College each year, the theoretical break-even point was reached, and the process of implementation begun. In consequence when, on the 3rd March 1871, the inevitable question was raised on the floor of the House of Commons and Mr. Dickinson asked the Under Secretary of State for India (Mr. Grant-Duff) "what will be the charge on the revenues of India of the proposed College for Engineers, what the building will cost and what will be the annual cost of the Establishment", this aspect proceeded without controversy. In his reply Grant-Duff proclaimed, "there will be no charge on the revenues of India on account of the Engineering College, the fees will be slightly in excess of the charges, including interest on the buildings and plant, say of £90,000. There will be eleven Professors and Instructors on salaries varying from £700 to £300 per annum ... If my Honourable friend would like the figures, here they are - Annual sanctioned charge for
College, as per regulations of Secretary of State in Council
£18,350, interest on buildings, etc., say £90,000 at 4%,
£3,600 : Total £21,950. Fees, 150 students at £150, £22,500.
Difference, £550".121 (Thus disposing of the grounds for
Fawcetts threatened intervening.)

However, although the matter of a self-supporting
Institution was theoretically resolved, the question of an in-
built monopoly remained. From mid-November 1870 to March 1871,
Memorials against the establishment of the Civil Engineering
College were received from the following institutions :122

King's College, London 21st November 1870
Queen's College, Galway 23rd November 1870
University College, London 22nd December 1870
Royal College of Science for Ireland 16th January 1871
Owens College, Manchester 7th February 1871

All of the Memorialists, with the exception of the Royal College
of Science for Ireland, who considered parts of the scheme
"commendable" and wanted modifications in the College rather
than its abolition, deprecated the establishment of the
proposed Civil Engineering College, as calculated to inflict
great injury on the educational Institutions already existing.
Thus, for example, King's College London argued 123 that it
would "inflict great hardship on voluntary educational
Institutions, which have been endeavouring, not unsuccessfully,
without the advantage of Endowment or Government Patronage, to
prepare candidates for the Indian Engineering Service, and which
will feel most injuriously the withdrawal of a privilege which
has hitherto been one great inducement to study, and one
important source of reward and distinction to their students".
Similarly the Trustees and Professors of Owens College,
Manchester, observed 124 "that amongst the studies pursued in
Owens College and in many other Colleges in the United Kingdom
are included those branches of Mathematical, Mechanical and Physical Science which form the basis of civil engineering and that, moreover, provision has recently been made in their Institutions for the special teaching of the subjects which constitute the science of engineering; and that, therefore, candidates in any part of the Kingdom are already supplied with means of obtaining those instructions which it is the object of the proposed College to supply".

Nevertheless, it is clear from the dates of this second batch of Memorials that the decision to purchase the Cooper's Hill Estate had already been taken (9th November 1870) and a draft prospectus containing the regulations governing admission and the course of study to be followed was almost completed. By December 1870 the first Prospectus of the Indian Civil Engineering College was published, and, consequently these appeals against the establishment of the College were submitted too late to have much impact. Indeed it is noteworthy that almost all of the Memorials from hitherto "recognised" Colleges were greeted with a standard reply from the India Office: "that the plan which has been decided on for the conduct of that Institution has been greatly misunderstood", or, that the Memorialists "have been to some extent misinformed" and enclosing a copy of the Regulations which "will it is hoped, suffice to remove any apprehension entertained by the Memorialists as to the operation of the contemplated arrangements". Indeed it is noteworthy that almost all of the Memorials from hitherto "recognised" Colleges were greeted with a standard reply from the India Office: "that the plan which has been decided on for the conduct of that Institution has been greatly misunderstood", or, that the Memorialists "have been to some extent misinformed" and enclosing a copy of the Regulations which "will it is hoped, suffice to remove any apprehension entertained by the Memorialists as to the operation of the contemplated arrangements". Notwithstanding the stereotype replies, the basic grievance of the Memorialists remained, viz. that the College constituted, de-facto, a monopoly in supplying the I.P.W.D. from an exclusive preserve. In a society where the principle of open competition had only recently become firmly established it is not surprising that many Parliamentarians would recommend
that its students be brought into competition with those educated elsewhere. Indeed one M.P. declared that there was no need to ask "where the horse gets his oats if he wins the race". 127

Thus on the evening of Friday the 3rd March 1871, Sir Francis Goldsmid, M.P. for Reading, rose in a Committee of Supply Debate to call the attention of the House of Commons to the recent establishment under the orders of the Secretary of State for India, of a Civil Engineering College, designed to train civil engineers exclusively for the I.P.W.D, and to move the following resolution: 128

"That in the opinion of this House, young men qualified by character and attainments for admission into the service of the Government of India as Civil Engineers, ought not to be excluded from such service by reason of their not having been educated at a Government College."

Goldsmid argued that the open competitions had failed because the terms offered had been "too low to attract young men of first-rate ability and attainments". In commenting on the newly increased salaries he wondered why such a liberal increase had not been tried in the first instance "instead of rushing at once to the foundation of a College?" Moreover on to the scale of fees involved he asked, "why were all to be excluded from the Government Service, however great their qualifications, who could not afford to pay for their Collegiate training £150 per year?" Indeed it appeared to him that the prospectus of the new College bore a striking resemblance to the advertisements for private academies, particularly paragraph 25 of the prospectus which required each student to furnish his own linen for use in his room. This reminded Goldsmid "of the usual declaration that every pupil must bring six towels; and though the accompanying silver spoon and fork
were not to be found in the present edition, he had little doubt that they would appear in the next.\textsuperscript{129}

However with regard to his resolution he conceived of three possible effects of allowing the "Government Collegians" to compete with those educated elsewhere. Either the Collegians would consistently prove superior or inferior or as appeared to him most likely, "success would be pretty equally divided between the two classes, and an honourable emulation would be kept up which would have a most wholesome effect on the professors and students of the College".

In seconding the motion, Mr. Dickinson,\textsuperscript{130} expressed grave concern at the powers of the Secretary of State for India. He objected to the Government undertaking education Institutions without consulting Parliament. "Why", he asked, "was all this to be done without any communications to the British Parliament or to the people of India? It was all done by the India Office at home, and they heard nothing whatever about it until the whole thing was completed". Moreover, he argued that "it was a case that called for the serious consideration of the Government, and one not to be settled by the mere \textit{ipse dixit} of the Secretary of State for India in Council.\textsuperscript{131}

The Under Secretary of State (Mr. Grant-Duff) in replying to the resolution noted that far from deserving blame in the matter, "I think we have done a thing absolutely necessary for India, and very advantageous to England.\textsuperscript{132} As to the allegation that the College injured "the great and sacred course of competitive examination - that best of expedients for the distribution of patronage in this bad world, which however threatens ere long to become a British fetish", he replied that the College was to be "absolutely open and purely competitive". Indeed, in order to prevent time spent at other
Institutions from being wasted, the College Prospectus contained the following clause:

"Although students will ordinarily be required to go through a three-year course, that condition may be dispensed with in the case of those who, on admission, shall satisfy the College authorities that they possess already a competent knowledge of the subjects taught at the College." 133

In consequence students could enter at once into the second or third year's course if they were already sufficiently qualified and thus become eligible for appointment to the public service after two years or one year, or even less, as the period could be further reduced in special cases "to a time sufficient to enable the student to go through the various exercises which form a part of the College final examination".

Turning to the scale of fees required at the College and to the allegation that it would merely be a College for the rich, Grant-Duff noted the comparatively high return a student would get on his investment. In any event "a youth who wished to become an engineer in this country had to pay a premium of from £300 to £500 a year to the engineer with whom he served his apprenticeship, to say nothing of the fees which he had to pay at any of the existing institutions where there were engineering classes". 134

Similarly, to those who argued that Government should await the report of the Royal Commission then sitting on scientific instruction, 135 he replied "while you were deliberating, we were suffering" and in this sense "we have done good service to English scientific education by acting, while its other well-wishers have been talking and inquiring".

Mr. Fawcett rose to protest that Parliament had not been consulted, whilst Sir Dominic Corrigan 135 speaking "on behalf of the authorities and students of the Queen's University in
Ireland" noted that "they looked upon the establishment of this College as putting an end to open competition. A worse species of nomination than that of patronage was nomination by money." On the other hand the Member for the Edinburgh and St. Andrews Universities (Dr. Lyon Playfair) spoke in favour of the scheme and contrasted it with the pupilage system where "a fee of from £300 to £500 was required with each pupil who had the run of the drawing and machine shops, but learnt nothing of the science of engineering, except what he could pick-up". As the representative of the only university that granted engineering degrees he thought the proposed College was "not a substitution for existing Institutions, but a mere supplementary and accessory means of promoting them". Nevertheless the chief argument against the College was the scale of the annual fees payable which he thought would exclude "poor young men of merit".

Similarly the Chancellor of the Exchequer (Robert Lowe) supported the College and maintained with great confidence that this system was fair and honest and well conceived for the purpose that it had in view; that it was founded on a spirit of justice to India, and of enlightened fairness towards all sister institutions.

All of the remaining speakers argued against the College, Mr. Winterbothan, Under Secretary of State, Home Department, protested against the project "not only as a gross injustice towards the educational institutions of the country, but as a slur on English education in that particular line in which it had been most successful"; "for if England had not produced engineers, he did not know what kind of genius she had produced". Mr. Gordon supported this argument whereas Colonel Sykes the Member for Aberdeen City expressed
concern that the natives of India would be excluded from the service. Sir John Lubbock praised the entrance examination where "justice had for the first time been done to physical and natural science", but also supported the open competition ensured by the terms of the motion before the House. Equally, Mr. Miller the Member for Edinburgh City, a practising civil engineer thought the proposed College would send men out to India "learned in theory only" and totally ignorant of practice. Finally, Dr. Ball identified two kinds of education required for an engineer, one Mathematical and scientific and the other practical and experimental. The first he argued was better taught in the Universities than in any other institutions, whereas the second could only be acquired by actual experience.

Plainly many of the speakers had taken the opportunity of Sir Francis Goldsmid's resolution to roundly condemn the proposed College. Moreover, when the motion was voted upon the Government were defeated by 52 votes to 46 in favour of the resolution. In consequence the issue of "open competition" was returned to the India Office, and in the next chapter the method of making this resolution consistent with the terms of the Indian Civil Engineering College will be examined.

In conclusion it is significant that in considering the Institutional and personal responses to the notion of State involvement in professional civil engineering education, correspondence from the Institution of Civil Engineers was conspicuous by its absence. In fact it was not until the 15th March 1871 that the Council of the I.C.E. submitted its views in a Minute against the proposed College, by which time arrangements were sufficiently matured to render the Minutes impact nugatory.

Not surprisingly the I.C.E. embraced the pupilage system
and regarded the establishment of a College as unnecessary and "not likely to be attended with favourable results".

The Council of the I.C.E. rejected the implied assertion "that the present means of attaining an adequate engineering training in this Country are defective", and extolled the merits of the pupilage system. Thus, "according to the ordinary system by which engineers are trained in this country, they are brought up under men of varied practice and distinct orders of mind; and during the period of probation upon works as pupils their character is developed and their fitness or otherwise for the profession is ascertained. But in the proposed College the minds of the pupils will all be moulded in the same forms. There will be none of the emulation of different schools of thought and action and none of that independence and originality of resource which have produced the best engineers". President Vignoles and the Council also argued that the competitive examinations had failed because of the "inadequacy of the emolument hitherto offered" and also because of the nature of the examinations which "in no way tested any of the qualifications of an engineer excepting a retentive memory and a certain aptitude for figures".

It was unlikely that the Duke of Argyll would be moved by such arguments, levelled as they were at the very raison d'être for the College, and in reply the Under Secretary of State expressed "His Grace's regret that the course which he has deemed it his duty to take in the matter to which the minute refers has not met with the approval of the Council of the I.C.E.".

Before turning to the mode of classifying students and the organization of studies at the College it is interesting to note the inclusion of the term "Royal" in the title of the
College. Chesney thought it was always usual to designate thus all Government Institutions of the kind, for example, Sandhurst was the "Royal Military College" and Woolwich "the Royal Military Academy", but he did not know whether any special authority was obtained for using the title, or whether it was applied as a matter of course, the title appeared simply to distinguish a State Institution from a private one.

On taking legal advice Argyll established that the term "Royal" could not be adopted, even by a State Institution, without the Queen's consent. Consequently it was "submitted for the approval of Her Majesty that the Indian Lunatic Asylum lately established at Ealing should be designated "the Royal India Asylum", and that the Indian Civil Engineering College at Cooper's Hill should be designated the "Royal Indian Civil Engineering College".¹⁴⁵
CHAPTER 3

Footnotes.

1. The "Bengal Furlough Pay Establishment Book" commencing 1864 (1OR/L/AG/20/6/30) shows Chesney (Estab.No.198) on furlough for two years from 14th May 1867 to 13th May 1869.

2. Report by his tutor, L.R. Roper, M.A., dated 4th November 1846 - attached to his application for admission to Addiscombe. See the "Addiscombe Cadet Papers 1846-1847" pp.94-100 (1OR/L/MIL/9/214).


4. See the "Thomason Civil Engineering College Calendar" (1871-1872) for a list of College Staff to that year, p.17.

5. Although "Indian Polity" was widely read it was not Chesney's most popular work. Two years later "The Battle of Dorking, or Reminiscences of a Volunteer" was contributed anonymously to Blackwood's Magazine. In it Chesney described an imaginary account of an invasion and conquest of England which was designed to provoke thought on the practical development of the volunteer movement for purposes of national defence. Subsequently published as a pamphlet it went through several editions and was translated into several languages.

6. See "Parliamentary Paper 115 of 1871" (hereafter P.P.115 of 1871) being a 'Return to an Address of the Honourable the House of Commons dated 15th March 1871', for a "Copy of all Correspondence which has taken place up to the present time between the Secretary of State for India in Council and the Governor General of India in Council, in reference to the establishment of an Engineering College at Cooper's Hill". Second Enclosure in No.2, dated Harrow, 22nd February 1869, pp.669.


8. Ibid. Quoted in 'First Enclosure in No.2' dated 30th January 1869, p.4, paras. 1 and 2. For details of the earlier examinations see 1OR/L/PWD/8/1 and 1OR/L/PWD/8/2. See especially the 'Report of the Examiners' dated 18th December 1868 in 1OR/L/PWD/8/2, p.146.

9. Rev. Dr. Alfred Wrigley formerly first Assistant Professor of Mathematics and Classics in the Military Seminary at Addiscombe. In fact Wrigley and Chesney shared a consensus of opinion on the measures necessary for rectifying the inadequacies of the competitive examinations. Wrigley's scheme is reproduced as 'First Enclosure in No.2' dated 30th January 1869, pp.4 and 5 (P.P.115 of 1871). For a comparison of the Wrigley and Chesney proposals see the Enclosure No.4 by Major General Baker.

10. Ibid, p.4.


13. This view of the existing Schools and Colleges was solicited at a time when his proposal to establish a new College was floundering on the rocks of opposition by the established institutions. It must therefore be treated with caution. Indeed Chesney went so far as to declare that "there is not a school or College in the Kingdom where an adequate engineering education is given. The best is Trinity College, Dublin, but even there the diploma is much too loosely bestowed. As for the Hartley Institution, Southampton, the Chester College & C., they are cramming schools of the most defective kind, where the means for instruction are ludicrously inadequate". Letter to the Duke of Argyll dated 2nd September 1870 in the "Argyll Papers" (KESQ 324).


15. Ibid.

16. Ibid.


21. The 'Board of Control' was created by Pitt's India Bill of 1784. It was designed to oversee political, military and financial control of British possessions in India.

22. The Member of Council for the P.W.D. was not officially appointed until 1874. See the "Cambridge History of India" in six volumes. Volume 6, "The Indian Empire 1858-1918" and "The Last Phase 1919-1947", (Delhi, Chard and Co.), p.231.

23. For further detail see S.N. Singh "The Secretary of State for India and His Council" (Munshi Ran Mohar Lar, 1962) See also the "Council of India Order Book (1858-1917)" for Miscellaneous Acts, memoranda, notes and correspondence on the powers of the Secretary of State and his relationship with the Council.

24. "Argyll Papers". Notes on the Auditor Question "Memo for the Cabinet" by Robert Lowe, January 1872. Indeed Lowe observed ruefully that "the Chancellor of the Exchequer cannot spend one farthing of Indian money ...".


29. See his "Inaugural Address as Chancellor of St. Andrews University", 1851.

30. He was deeply interested in both science and religion and strove continually to reconcile his religious views with the progress of scientific discovery. To this end he later published "The Reign of Law" (1866); "Primeval Man" (1869); "The Unity of Nature" (1884); "The Unseen Foundations of Society" (1893), as well as numerous other essays.


33. "Argyll Papers".

34. "Argyll Papers". 'Memorandum on the proposed Civil Engineering College' by Sir H. Rawlinson, dated March 1869.


37. "Argyll Papers". Memorandum of Sir G. Clark dated 6th March 1869 (op.cit.) Clerk also added "I can conceive no means as well adapted ... so effective, and in the long run so economical as that of a College in the form sketched by Major Chesney".


"Argyll Papers". Memorandum from Sir J. Hogg entitled "Engineers", dated 8th March 1869.

"Argyll Papers". Memorandum from W. Mangles entitled simply "Memorandum" and dated 9th March 1869.

Ibid.

"Argyll Papers". Memorandum from E. Macnaughton entitled "Proposed College for training Civil Engineers", dated 15th March 1869.

Ibid.

"Argyll Papers". Memorandum from H. Princep entitled "Proposed establishments of a College for Civil Engineers", dated 10th March 1869.

"Argyll Papers". Memorandum from Sir H. Montgomery without title and dated simply "March 1869".


"Argyll Papers". Memorandum from Mr. W. Arbutnot entitled "Memo." and dated March 1869.

"Argyll Papers". Memorandum from Sir B. Frere entitled "Memorandum on proposed Civil Engineering College", dated 20th March 1869.

Ibid.

Ibid.

Ibid.

See "Parliamentary Paper 115 of 1871" (op.cit. footnote 6), pp.9-17.

Ibid, p.11.


Ibid. In forwarding Baker's letter to the Duke of Argyll, Mr. Grant-Duff added that he (Grant-Duff) did not agree with Gen. Baker that the head of the College should be a military man.

"Argyll Papers". Baker to Grant-Duff (op.cit. footnote 57), dated 23rd August 1869.

Ibid.

"Minutes of the Council of India", July to December 1869. Volume C/23. Meeting on Thursday, 25th November 1869, refers to the draft despatch "which was laid before Council on the 18th inst.".
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62. Ibid. In fact there were 12 members present at this meeting viz. Arbuthnot, Baker, Currie, Frere, Halliday, Hogg, Macnaughton, Mangles, H. Montgomery, R. Montgomery, Perry and Rawlinson, with the Duke of Argyll presiding. Excluding Argyll, it is not clear which member did not vote (there is no record of an abstention) but the following Members were dissentient, Hogg, Macnaughton and Mangles. The voting however, is recorded as "Ayes 8, Noes 3".

63. When formally written, this despatch, from the Secretary of State for India in Council, to His Excellency the Right Honourable the Governor General of India in Council, was numbered "Public Works - No.119" and dated "India Office, London, 30th November 1869". For a reprint see "Parl. Paper 115 of 1871", pp.1-2. The drafts of this despatch are contained in the collection, "Drafts of Despatches 1868", 1OR/L/PWD/3/303.


65. This comment is pencilled on to the draft despatch but unfortunately is not initialed or signed. See Draft in 1OR/L/PWD/3/303.

66. General Baker's comments are attached separately to the P.W. Despatch in 1OR/L/PWD/3/303.


68. Ibid, p.19.

69. Ibid, p.21 (my emphasis).

70. "Minutes of the Council of India", July - December 1870, Volume C/25, p.42. (Meeting on 19th July 1870 refers to this Despatch "which was laid before Council on 30th ultimo").


72. Ibid.


75. "Engineering", Volume 9, 10th June 1870, p.423 (letter).


77. Memorandum from Sir H.B. Frere to Argyll (op.cit. footnote 52)

78. The letter to Lord Derby was from the Regius Professor of Civil Engineering and Mechanics, W.J. Macquorn Rankine, and
78. (continued) 
 dated '59 St. Vincent Street, Glasgow, 3rd August 1870'. 
 A copy was forwarded to the Duke of Argyll - see "Argyll 
 Papers".

79. Ibid.

80. See the covering letter from Derby to Argyll dated 
 'Knowsley, 5th August 1870', enclosing a copy of Rankine's 
 letter to Derby. "Argyll Papers".

81. Letter marked 'private' from Argyll to Derby dated 6th 
 August 1870. "Argyll Papers".

82. Ibid.

83. This Memorial is contained in the "Argyll Papers" but the 
 bulk of the later Memorials are to be found in the "Civil 
 Engineers Home Correspondence 1871", 1OR/L/PWD/2/225.

84. "Argyll Papers". This Memorial (without date) was 
 submitted via the Chancellor of the University of Dublin, 
 Lord Cairns. However, the covering letter from Lord 
 Cairns is dated '5 Cromwell Houses, W., 8th November 1870'.

85. See the first bundle of documents in "Civil Engineers Home 
 Correspondence 1859-1864", Volume 1, (1OR/L/PWD/2/222), for 
 the correspondence between the Secretary of State for India 
 (Sir Charles Wood, later Lord Halifax) and the Deputation 
 from Trinity College, Dublin, on 19th July 1859.

86. The Memorial of the University of Dublin, November 1870 
 (footnote 84) contains this statement which is based on the 
 Secretary of State's reply to the Deputation of 19th July 
 1859 and included in subsequent advertisements for appoint-
 ments. (1OR/L/PWD/2/222).

87. Memorial from the University of Dublin, (op.cit. footnote 84)

88. See "Civil Engineers College Home Correspondence 1871", 
 (1OR/L/PWD/2/225) bundles of correspondence in this volume 
 are grouped in numbers from 1-213.

89. 1OR/L/PWD/2/225, Number 10.

90. See 1OR/L/PWD/8/1-2 for the places of education of successful 
 candidates. These figures were accepted fairly uncritically 
 by Col. Chesney in his Memorandum to the Duke of Argyll dated 
 9th August 1870, entitled "Effect of the Establishment of the 
 new Government Civil Engineering College on the different 
 Colleges which profess to give an engineering education". 
 "Argyll Papers". However, it is unfortunate that no records 
 were kept of the educational antecedents of the unsuccessful 
 competitors. It is therefore not possible to state, with 
 any degree of accuracy, the relative success rate of 
 'University' to 'pupillage' competitors. C\^\_ P. 180. (inj)-9


92. Ibid.
This 'announcement' was made in reply to a question from Mr. Plunkett, M.P., who wished to know whether it was Government's intention to establish an Engineering College. The Under Secretary of State for India, Mr. Grant-Duff, replied in the affirmative and added that the College would be entered by competitive examination. See Hansard's Parliamentary Debates, Third Series, Vol. CCIII, July to August 1870, Column 1733.

"Argyll Papers". Letter from Henry Fawcett, M.P., to the Secretary of State for India dated 'Trinity Hall, Cambridge, 12th August 1870'.


"Argyll Papers". Letter from Halifax to Argyll dated 25th August 1870. Halifax had been Secretary of State for India from June 1859 to February 1866.

"Argyll Papers". Letter from Col. Chesney to the Duke of Argyll dated 'India Office, 2nd September 1870'.

In fact opposition to the scheme was carefully monitored by Chesney who submitted several reports to the Duke of Argyll in evaluation of such opposition. See for example his reports dated 23rd August 1870 and 26th September 1870. "Argyll Papers".

Chesney's views on the Government of India's reaction to the proposal are contained in a letter from the Secretary of the P.W.D., W.G. Thornton, to the Duke of Argyll dated 18th October 1870. "Argyll Papers".

At this time also, a Committee under the Chairmanship of Lord Lansdowne was sitting at the War Office considering the Employment of Royal Engineer Officers. On the 23rd August Lansdowne wrote to Argyll to request unofficially that Argyll await the outcome of his deliberations before establishing the new College. However by the 29th August 1870 Lansdowne outlined "the view which the Committee take of the Indian part of the question" and it was not prejudicial to the proposed College. See "Argyll Papers" letters from Lansdowne to Argyll for those dates. Also Reel 321 for the Resolutions of the "Committee on the Employment of Officers, Royal Engineers".

See "Argyll Papers", Chesney's Memorandum to Argyll dated 23rd August 1870 (op.cit. footnote 98). At this stage no formal opposition to the scheme had been received from the I.C.E.

Ibid.

"Argyll Papers". Letter from W.G. Thornton to the Duke of Argyll dated 18th October 1870. On this point Chesney also thought that objectors would derive artificial strength from the very pains taken to meet them. Thus, "People may say that the case for the defence must be really weaker than it looks if so laboured an argument on its behalf is thought necessary". See the memorandum from Chesney to Argyll dated 26th September 1870.
Mr. Gladstone's views are enclosed in a letter from the Duke of Argyll to his private secretary, Mr. W.H. Bentall, dated 21st October 1870. In this letter Argyll instructs his Secretary to show Mr. Gladstone's comments "to Sir U. Baker, Thornton and Chesney." "Argyll Papers".

Argyll also noted that "without the support of my colleagues, with certain opposition in the House, and a large apparent expenditure, I do not feel justified in proceeding. It is a great pity."

Chesney was given the initial authority to survey the likely buildings but this was to be supported by Wyatt's professional assessment.

For details see 1OR/L/PWD/8/8, pp.123-125 and 1OR/L/PWD/8/7, pp.69-76.

Chesney's Report dated 16th July 1870 in 1OR/L/PWD/8/8, pp.142-143. See also the "Minutes of the Council of India" for the 4th August 1870 (Volume C/25, p.90).

Contained in 1OR/L/PWD/8/8, p.125. This decision was ratified by the Council of India on the 4th August 1870.

See the opening remarks in the Memorandum entitled "Proposed Purchase of Cooper's Hill Estate for the Purposes of the Proposed Civil Engineering College", dated 9th December 1870 (1OR/L/PWD/8/8, p.151).


Ibid.

"Argyll Papers". Letter from Chesney to Argyll dated 'London, 12th October 1870'.

"Argyll Papers". Letter from Thornton to Argyll dated 18th October 1870.

"Memo. as to the eligibility of an estate at Cooper's Hill for the proposed Establishment for training engineers for the Indian Service" by Sir Digby Wyatt, dated 27th October 1870, (1OR/L/PWD/8/7, p.113).

"Argyll Papers". Letter from Col. Chesney to the Duke of Argyll dated 27th October 1870. Chesney was very "anxious" that his opinion might differ from an unbiased professional authority ...


This estimate is included in 1OR/L/PWD/8/7, pp.144-146. See also the "Contingent Expenses for 1870-1871 and Imprest Account", p.148.

121. Ibid.

122. The Memorials are contained in the volume of documents numbered 1-213 and referred to as "Civil Engineers College Home Correspondence 1871", 1OR/L/PWD/2/225.

123. Memorial from the Council of King's College, London (without date but the covering letter is dated 'King's College, 21st November 1870), 1OR/L/PWD/2/225, number 22/23.

124. Memorial from the Trustees and Professors of Queen's College, Manchester (signed by all of the Professors including Osborne Reynolds as Professor of Engineering) without date. This Memorial was received at the India Office on 7th February 1871 and replied to on the 22nd February 1871. 1OR/L/PWD/2/225, number 75 (op.cit.).

125. Not only were these memorials submitted 'post factum' but an orchestrated propaganda campaign is evident in the columns of the press throughout December 1870 and January 1871 extolling the merits of the new scheme. See for example "The Standard", 20th December 1870 (which regarded the new College as 'beyond praise in the excellence of its aims'). "The Times", 14th December 1870; "The Daily News", 3rd December 1870; "The Engineer", 6th January 1871.

126. See for example the reply from the India Office to the Memorial from Owen's College, dated 22nd February 1871. 1OR/L/PWD/2/225, number 75.


128. Hansard, Volume CCIV (op.cit.) column 1326.

129. Ibid, column 1328.

130. M.P. for Stroud.

131. Ibid, column 1331.

132. Ibid.

133. See paragraph 18 of the first Prospectus, 1OR/L/PWD/8/8, pp.291-293.

134. Hansard, Volume CCIV (op.cit.) column 1336.

135. i.e. the famous "Devonshire" Commission.

136. Hansard, Volume CCIV (op.cit.) column 1345.

137. Ibid, column 1354. In fact the following Members representing Universities spoke in the Debate: Rt.Hon. E.S. Gordon (Glasgow University); Dr. Lyon Playfair (Edinburgh and St.Andrews University); Rt.Hon. Robert Lowe, Chancellor of the Exchequer (London University);
137. (continued)
Rt. Hon. J.T. Ball (Dublin University).

138. Ibid, column 1348.

139. M.P. for Glasgow University.

140. Col. Sykes was the only M.P. to challenge the proposal on behalf of potential Indian candidates.

141. Hansard, Volume CCIV, Column 1349.

142. "Minute of the Council of the I.C.E. on the proposed Indian Civil Engineering College" in 1OR/L/PWD/2/225, number 14. The covering letter from the I.C.E. President, Charles B. Vignoles, is dated '25 Great George Street, Westminster, 18th March 1871'.

143. Ibid.

144. Reply from Herman Merivale dated 29th June 1871 (1OR/L/PWD/2/225, number 14).

145. "Argyll Papers". Memorandum (without signature) dated 21st June 1871. However, the proposal did not reach the Queen for some time for in Letter No.19 of 5th January 1875 from Chesney to the Under Secretary of State Chesney notes 'I have the honour to acknowledge the receipt of your letter of yesterday, informing me that the Queen has been graciously pleased to approve the Indian Civil Engineering College being called the R.I.E.C.' 1OR/L/PWD/8/23.

Although the Marquis of Salisbury had procured for it this distinction, the College was to be known throughout its existence as Cooper's Hill College. This later led one disgruntled graduate of the College to write to "Indian Engineering" (30th April 1892, p.348) that the site at Cooper's Hill was selected by chance; it might equally have been possible that No.13 Queen's Road, Bayswater was chosen in which case the alumni would have been dubbed 'No.13 Queen's Road, Bayswater Engineers'.


Preparations for opening the new civil engineering college were well advanced by the time of the Parliamentary Debate in March 1871, and, although many objections to the principle of the scheme were raised in Parliament, they did not significantly obstruct the backstage arrangements for opening the new College. The terms of Sir Francis Goldsmid's resolution were merely accommodated within a revised prospectus issued shortly after the debate.¹

Behind the scenes the Public Works Committee had approved the following advertisement for publication on the 26th November 1870.²

"Indian Civil Engineering College, Cooper's Hill, Surrey. Notice is hereby given that a competitive examination will be held in June next for the selection of 50 candidates for admission to this College. The examination will be open to all British born subjects of good character and sound constitution who are between the ages of 17 and 21 years. The successful competitors, after undergoing a course of instruction at the College, including a practical course under a civil or mechanical engineer, and on being found qualified, will be appointed to the Engineer Service of the Indian Government on a salary commencing at Rs. 4,200 (about £420) per annum".

The examination subjects were to be those of a normal English education and were listed as:³

<table>
<thead>
<tr>
<th>Subject</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>English - composition</td>
<td>500</td>
</tr>
<tr>
<td>- history and literature</td>
<td>500</td>
</tr>
<tr>
<td>Mathematics - pure and mixed</td>
<td>500</td>
</tr>
<tr>
<td>Latin</td>
<td>1,000</td>
</tr>
<tr>
<td>Greek</td>
<td>1,000</td>
</tr>
<tr>
<td>French</td>
<td>750</td>
</tr>
<tr>
<td>German</td>
<td>750</td>
</tr>
<tr>
<td>Natural and Experimental Sciences, limited to not more than three of the following four branches: (a) Chemistry, (b) Heat and Light, (c) Electricity and Magnetism, (d) Geology and physical geography</td>
<td>2,000</td>
</tr>
</tbody>
</table>
To ensure the widest circulation possible the advertisement was inserted for publication in:

- The Times
- Daily News
- Post
- Pall Mall Gazette
- Echo
- Daily Telegraph
- Spectator
- Saturday Review
- Athenaeum
- Standard
- Dublin General Advertiser
- Glasgow Saturday Post
- Edinburgh Evening Courier
- Engineer
- Engineering
- Builder

The publicity thus given to the embryo College was very complete and enquiries and applications from potential candidates began to flood in to the Civil Service Commissioners and to the P.W.O. of the India Office - despite the fact that the charge to be made to students at the College was clearly stated to be at the rate of £150 per annum.

By the end of November 1870 a Prospectus had also been published which elaborated upon the admission requirements and gave a resume of the intended College course together with some brief detail concerning the I.P.W.O. At the competitive entrance examination two subjects were regarded as compulsory, viz. English Composition - (to the extent of a candidate's being able to write grammatically and with correct spelling) -
and Mathematics - (arithmetic, algebra, geometry (first four and sixth books of Euclid), mensuration and plane trigonometry).

Although candidates were required to obtain not less than one fourth of the aggregate marks assigned to the two compulsory subjects it is clear that this examination was to be competitive only in the sense that the fifty candidates highest in the results list were to become entitled to admission, irrespective of any other standard of excellence.

The College course of three years was to be divided into nine terms of which at least two, in the third year, with the intervening vacation, were to be passed by the students under a civil or mechanical engineer, or partly under each. A payment of five shillings per day in lieu of commons would be made to each student while thus detached and this money together with the engineers fees for accepting the students was to be paid by the Indian Government.

As the Indian Civil Engineering College represented a significant departure from the prevailing system of civil engineering education there was a clear need for a reasonably exact definition of the character and extent of knowledge which it was desirable that the young civil engineer should possess prior to entering upon the actual practice of his profession. When defining the curriculum to be pursued at the College, Chesney consulted both academics and practitioners and listed the subjects as:

- Mathematics, pure and applied with the mechanics of engineering
- Civil and mechanical engineering
- Elementary principles of architecture
- Surveying
- Mechanical drawing
- Physical science
- Hindustani and history and geography of India, and Accounts.

This list of fundamental subjects was to be augmented by
optional courses in Higher Mathematics, Architecture, Freehand Drawing and Physical Science, all in extension of the obligatory course, and, designed for the students personal gratification.

Student's progress would be tested by periodical examinations and by the assignation of values to the drawings, surveys, reports, etc., executed by them whilst at the College as well as to the work done while detached under civil or mechanical engineers. Although not defined, a qualifying standard of proficiency was to be attained by students at the end of the first and second years failing which a student would not be allowed to remain at the College.

The final examination to be held in July of the third year would be divided into the four branches of:

I. Engineering - including drawing and surveying;
II. Mathematics - including the mechanics of engineering;
III. Physical Science;
IV. Language - ancient and modern, including Hindustani and History and Geography of India.

Armed with this information, 220 candidates presented themselves for the first entrance examination for the Indian Civil Engineering College which was held at London University in Burlington Gardens, under the direction of the Civil Service Commissioners, from the 13th June to 27th June 1871. This initial response to the new College (at least in terms of quantity) must have proved satisfying to Argyll and Chesney as the examination undoubtedly marked "an epoch in engineering education in this country"; however, of the 220 candidates, 108 failed to pass the qualifying examination in one or both of the two prescribed subjects and were not allowed to proceed with their examination. The remaining candidates who completed the examination were ranked according to their aggregate marks
and the first fifty were recommended for admission.

Purchase and Alteration of Cooper's Hill

Parallel to publishing the Prospectus and organizing the first entrance examination, site developments were proceeding apace. As noted above (Chapter 3, p.126) Sir Digby Wyatt and Colonel Chesney were empowered to purchase the Cooper's Hill Estate near Egham in Surrey on the 9th November 1870, for a sum "not exceeding £55,000".

This recommendation was based largely on Wyatt's report of 27th October in which he stated that half of this outlay could be set against the value of the Freehold Estate, timber, gardens and ornamental planting and the other half represented the cost of the buildings upon that estate. Moreover, Wyatt had "not a shadow of doubt that but for the present untoward financial and political state of things it would have sold, long ago, for more than that sum".

During the summer Chesney and Wyatt had considered the amount of accommodation both indispensible and desirable for a College so that when Wyatt focussed attention on the plans of the existing buildings at Cooper's Hill, he saw how far they went in supplying what was desirable and the necessary alterations and additions required to render the establishment complete.

From this perspective Wyatt noted that the existing structure required little alteration to provide "all the apartments necessary for academical purposes. A suitable residence for the Principal and three unmarried Professors - rooms for a Bursar or House Steward - complete domestic offices, and bedrooms for female servants", together with sleeping accommodation for twenty students. Beyond this existing accommodation Wyatt noted that initially accommodation should be provided for
two married Professors and 'say fifty-five students', and, as it was essential to preserve the value of the estate he indicated points where the two Professors' houses could be erected without impairing the estate's value. However, for the fifty-five students' rooms he noted that thirty-four could be economically provided in a new building detached from the main building but communicating with it on the ground floor, and the remaining twenty-one rooms could be provided by raising parts of the office wing of the main house.

In consequence, Wyatt estimated the cost of the works as:

For the new buildings £ 8,000
Raising two stories upon portions of existing buildings £ 2,000
Two houses for married Professors, including gardens and grounds £ 3,000
For alterations to the existing structure, say £ 3,000

Total £ 16,000

Hence, for a total sum of £71,000 the Government would be "provided with a complete Collegiate establishment, handsome in every respect, fit for training 75 students". Wyatt's report also indicated that additional students rooms could be provided at a moderate cost.

The following tabulated statement shows a comparison between the accommodation considered desirable by Chesney and Wyatt and that provided for in the above estimate.
Once in possession of the order to purchase Cooper's Hill, Chesney and Wyatt immediately communicated the formal offer of £55,000 to Baron Grant and upon the latter's acceptance Chesney
was greatly relieved. He noted, "I felt satisfied from the first that it was the place for us, and it is a great satisfaction to know that the matter is concluded". Anxious "not to let the grass grow under the lawyer's feet", Chesney and Wyatt lost no time in instructing the solicitors for the India Office - Messrs. W.H.S. Lawford of Drapers Hall, Austin Friars, City - to carry out the transaction and stated "we shall be happy to do anything in our power to expedite carrying the above into effect, having received personal directions from the Secretary of State in Council to the effect that it is desirable that the matter should be completed "at once".

On the 17th November, Wyatt received permission to proceed with the working drawings and together with Chesney "and assisted by numerous draughtsmen" they immediately set to work with the intention of giving detailed instructions to a builder. Working drawings and proposals for a builder, surveyor and clerk of works were subsequently submitted to the Public Works Committee on the 9th January 1871, although the estate had not yet passed into the hands of the Government.

The details of the working drawings differed slightly from Wyatt's estimate of 27th October. The new plans envisaged accommodating the President and three unmarried Professors in the College and six married Professors instead of two on the estate, together with accommodation for 100 students. The builders recommended were Messrs. Ashby and Horner of Aldgate, an "old and much trusted" firm of the Secretary of State for India who had recently completed the Indian Lunatic Asylum at Ealing. Indeed, because of Wyatt's confidence in this firm, tenders were not invited from others, and as Messrs. Ashby and Horner had agreed to abide by the "measurements, quantities and pricing out of all their work by Mr. H.F. Gritten, surveyor,
acting as Assessor between the Secretary of State in Council and themselves", they were awarded the contract. Wyatt also recommended the employment of a clerk of works at a salary of £3 per week and concluded "time is now pressing hard, and I am anxious that not an hour should be lost in setting to work after the conveyance of the estate may be completed ... I am awaiting almost hour to hour the fixing of an early date for the transfer of the estate".

The delay in executing the Deeds was due to Baron Grant's mortgage brokers who had refused to accept immediate repayment of their loan, but this difficulty was resolved towards the end of January and the estate finally became the property of the Government on the 30th January 1871. On the following day Wyatt attended at Cooper's Hill and took possession on behalf of the Secretary of State, and, accompanied by the "Builder, Surveyor and Clerk of Works, with the foreman who will take charge of the job, and those of my assistants who had been principally engaged upon the drawings and tracings, I set out the principal buildings, and started the contractor actively upon his work".

Meanwhile Chesney had made the necessary arrangements for preventing the Estate deteriorating during the progress of the works by, inter alia, the employment of a police constable to patrol the grounds. Chesney was further engaged in estimating the necessary fixtures and fittings required for the College and with a total allowance for this purpose of £10,000 he visited Sandhurst and "a College at Cambridge of 100 students" to gauge the detail of his requirements. Orders were later placed with Messrs. Fox and Son and Messrs. Vardon and Son (both suppliers to the India Office) for furniture and hardware respectively.
Throughout his negotiations with Messrs. Fox and Vardon, Chesney noted that his object was to select the "cheapest articles consistent with strength" and when finally allocated the £10,000 was distributed thus:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture for: students rooms (approximately £28 per room)</td>
<td>£2,800</td>
</tr>
<tr>
<td>: College rooms</td>
<td>£1,400</td>
</tr>
<tr>
<td>: President's quarters</td>
<td>£700</td>
</tr>
<tr>
<td>Ironmongery for: College purposes</td>
<td>£670</td>
</tr>
<tr>
<td>: President's quarters</td>
<td>£130</td>
</tr>
<tr>
<td>Cutlery and Plates</td>
<td>£100</td>
</tr>
<tr>
<td>Glass and Crockery</td>
<td>£100</td>
</tr>
<tr>
<td>Fitting of laboratory and lecture room</td>
<td>£500</td>
</tr>
<tr>
<td>Scientific apparatus, models and C.</td>
<td>£1,400</td>
</tr>
<tr>
<td>Contingent and unforeseen items</td>
<td>£200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£8,000</strong></td>
</tr>
</tbody>
</table>

Of the remaining £2,000, half was spent on purchasing items (such as farm implements) from Baron Grant and the other £1,000 was regarded as an 'available reserve' to be used on either furniture or fittings for the College as required. Clearly any estimates for scientific apparatus, text books, etc., were approximate and the necessary detail could not be supplied until the academic staff were appointed. Nevertheless the building work proceeded rapidly so that the accommodation and necessary furnishings for 50 students were completed by the summer and the College was prepared for its formal opening on the 5th August 1871, (although the contractors men had a further month's work to complete before the students could actually enter for their first term). By the end of May 1872 the remaining alterations and accommodation for a further 50 students were complete and the contractors men had left, having completed the works for a total cost of £30,932.17.7
Constitution and College Establishment

On the 28th July 1870 the Council of India approved a draft constitution for the proposed Civil Engineering College. The Constitution noted that the relation of the Secretary of State in Council to the new College was to closely resemble that of a Governing Body under the Public Schools Act 1868, to the public school which it governs. In this sense the Secretary of State owned all the property of the College and was responsible for the appointment and, if necessary, the dismissal of the President, and indeed the authority of the President and of everyone else at the College was derived directly or indirectly from him.

However, recognising the scope of the Secretary of State's responsibilities, and the fact that he had neither the time nor special qualifications necessary for the management of such a place, his policy was to remain in the background and delegate his authority as far as possible. Initially this authority was delegated to the President, for, although the constitution envisaged the appointment of a Board of Visitors, this body was not established until 1880. In this context Chesney was treated throughout 'the first ten years' with total confidence and assured of the widest possible discretion in organizing the College and subsequently in its management and administration - hence his imprimatur was everywhere apparent. Nevertheless, as the Secretary of State was responsible to Parliament and the public for the acts of his officers, the constitution stipulated that any new or exceptional measure likely to be publicly challenged, should, if possible, be referred to him before being adopted.

The constitution also envisaged that Professors would be appointed for five years with the understanding that this
period may occasionally be extended, but a subsequent minute of the 10th February 1871 ordered "that the five years limit should be abandoned and that the Professors should be engaged during pleasure", 26 although the engagement could be terminated by six months notice on either side without reason being assigned. As Chesney alone was responsible for nominating the Professoriate to the Secretary of State, he had made overtures to many engineers and academics throughout the summer and autumn of 1870 so that when the scheme finally reached "take-off" point his quest for potential candidates was well advanced. However for the most senior position in the College, that of Professor of Engineering, Chesney noted that "I should not be doing my best for the College if I were to look elsewhere" 27 than to Professor Fleeming Jenkyn, who had recently removed (1868) from the Chair of Engineering at University College London to occupy the newly established chair at Edinburgh, and with whom, Chesney plainly had a consensus of opinion on the need for a systematic and scientific engineering education. In December 1870 he wrote to Jenkyn: 28

"My Dear Sir,

Your reputation as a teacher and writer on engineering education will be I hope sufficient apology for the liberty I take in addressing you direct. The Indian Civil Engineering College has now been established, as you will no doubt have seen by the advertisements. One important element for its success will consist in the making a good selection for the Chair of Engineering, and without wishing to commit myself or the Government, I may say at once that it would probably tend to simplify the search for a fitting man if I knew that the idea of occupying it would be likely to be agreeable to you."

Jenkyn, however, was not to be tempted by the attractions of £700 a year with a residence combined with the advantage of teaching a class of "picked men" so that attendance and attention at lectures was secure, instead of "having to take
all who choose to come", (Chesney's reference to University students voting with their feet on the relative quality of different lectures and lecturers).

Despite his rejection of the offer, Jenkyn nevertheless expressed sympathy with the scheme and recommended that an approach be made to Mr. Calcott Reilly - a civil engineer of repute - and it is doubtless that Reilly was subsequently appointed because of the high opinion Jenkyn entertained of him (an opinion also shared by Professor W.J.M. Rankine).

Chesney's basic requirements for the engineering chair were that the person appointed "should combine practical experience with a certain degree of scientific attainments and who would be likely to possess the art of communicating his knowledge" together with a total commitment to this new system of engineering education. At 43 years of age, Calcott Reilly was a Member of the I.C.E. and possessed a thorough practical knowledge of his profession, especially mechanical engineering, and also scientific attainments of a high order as evidenced by his elaborate investigations and occasional publications on the Mathematical conditions of iron bridges "which have been greatly commended by some of the most eminent authorities on such subjects". He was also totally committed to the need for reform in engineering education and later recalled Chesney's technique used to evaluate this commitment. Writing in April 1871, he noted:

"About two months' ago Dr.Pole sent for me into his room in this house, (the I.C.E.), and when I got there I saw him seated with a gentleman whom he introduced to me as Colonel Chesney, and then proceeded to explain that he wanted me confidentially to give my opinion of the qualifications of a certain gentleman for this post. This opinion I gave freely and very much in the gentleman's favour, and they led the conversation on to the general subject of the technical education of engineers, and I talked away for two hours. In point of fact the enquiry was, as Dr.Pole afterwards informed me, only an excuse - the gentleman
referred to being considered too old - the object being to trot me out on my hobby-horse so as unconsciously to show Colonel Chesney my paces, the Colonel playing the part of devil's advocate."

Chesney was clearly sufficiently impressed with Reilly's commitment and in his letter of recommendation to the Secretary of State he declared Reilly to be "one of the strongest advocates for thorough reforms in engineering education and for introducing into the training of English engineers something of that systematic preparation which is carried out in France and Germany". 32

When offered the post Reilly could not resist so "tempting a chance", and, although he had not applied for the position, it is nevertheless noteworthy that as soon as the advertisements began to appear in the newspapers applications for diverse academic positions began to pour into the India Office. Altogether there were eight candidates for the Chair of Engineering but a disparate range of specialists also offered their services - including Professors of French, German, English Literature and History. The Chair of Mathematics attracted ten candidates 33 from whom the Rev. Joseph Wolstenholme, M.A., and late Fellow of Christ's College Cambridge was selected. Wolstenholme had graduated in 1850 as Third Wrangler and possessed a reputation at Cambridge (where he occupied the post of Proctor) as a man of high culture and a very accomplished Mathematician. He was joint author of a work on higher geometry and his standing as a teacher was achieved first as Fellow of St. John's and afterwards as Fellow and Tutor of Christ's College.

By March 1871 three other Professors were tentatively appointed to the Chairs of Chemistry, Surveying and Geometrical Drawing. For Chemistry or 'experimental science' Chesney had great difficulty in making a selection from eleven highly
qualified candidates including Professor Foster from University College London. However, the post eventually went to Herbert McLeod who had been for some years Demonstrator at the Royal College of Chemistry and at 30 years of age had an established reputation as an experimentalist in both Chemistry and Physics. For Surveying, four candidates were shortlisted, and the appointment of Captain William Henry Edgecombe of the Royal (Madras) Engineers was recommended. Edgecombe had a total of twenty years service experience during which time he had superintended an extensive survey of Pegu and for the last eight years was Head of the Madras Civil Engineering College. When news reached Edgecombe that a site had been purchased for the proposed Engineering College he wrote to Chesney expressing his desire to return home and retire from the service if he could secure an appointment at Cooper's Hill - to which Chesney readily agreed.

The Chair of Geometrical Drawing went to another military officer Lieutenant George Sydenham Clarke who accepted the post when the first nominee accepted preferable employment at the War Office. Two instructors were also appointed: one for Hindustani and History and Geography of India which was filled by Mr. Cotton Mather who had considerable experience in a similar capacity at Addiscombe and Woolwich; the other for Landscape Drawing which went to Samuel T.G. Evans who had been similarly employed at Eton College.

With the appointment of the principal academic staff in May, Chesney soon after charged his colleagues with the purchase of the necessary scientific apparatus (within the financial parameters mentioned above) and the construction of a detailed syllabus of study for each discipline.

Preliminary arrangements also included the appointment of subordinate staff at the College and the following table shows the
designation names, salaries and dates of appointment of all
staff appointed prior to the official opening of the College
on the 5th August 1871.

<table>
<thead>
<tr>
<th>Office</th>
<th>Name</th>
<th>Salary</th>
<th>Date of Appointment</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>Lt. Col. George Tomkyns Chesney</td>
<td>£1,000¹</td>
<td>19 May 1870</td>
</tr>
<tr>
<td>Professor of Construction</td>
<td>Calcott Reilly, Esq.</td>
<td>700²</td>
<td>1 May 1871</td>
</tr>
<tr>
<td>Professor of Mathematics</td>
<td>Rev. Joseph Wolstenholme</td>
<td>600²</td>
<td>1 May 1871</td>
</tr>
<tr>
<td>Professor of Physical Science</td>
<td>Herbert McLeod, Esq.</td>
<td>600²</td>
<td>1 May 1871</td>
</tr>
<tr>
<td>Professor of Surveying</td>
<td>Capt. W. H. Edgcombe, R.E.</td>
<td>600²</td>
<td>6 Jun 1871</td>
</tr>
<tr>
<td>Instructor in Mech. Drawing</td>
<td>Lt. George Sydenham Clarke, R.E.</td>
<td>450</td>
<td>12 May 1871</td>
</tr>
<tr>
<td>Instructor in Hindustani &amp; History of India</td>
<td>Cotton Mather, Esq.</td>
<td>350³</td>
<td>1 Aug 1871</td>
</tr>
<tr>
<td>Instructor in Landscape Drawing</td>
<td>S. T. G. Evans, Esq.</td>
<td>300⁴</td>
<td>1 Aug 1871</td>
</tr>
<tr>
<td>Clerk</td>
<td>B. D. Dawers, Esq.</td>
<td>150</td>
<td>1 Jun 1871</td>
</tr>
<tr>
<td>Draughtsman and Assistant Clerk</td>
<td>H. C. Harris, Esq.</td>
<td>80</td>
<td>7 Sep 1871</td>
</tr>
<tr>
<td>Bailiff</td>
<td>Mr. F. Robinson</td>
<td>84⁵</td>
<td>1 Feb 1871</td>
</tr>
<tr>
<td>House Steward</td>
<td>Mr. H. Lewis</td>
<td>150</td>
<td>6 Jul 1871</td>
</tr>
<tr>
<td>Messenger</td>
<td>Mr. G. Underwood</td>
<td>70</td>
<td>13 Jun 1871</td>
</tr>
<tr>
<td>Porter</td>
<td>Mr. H. Prince</td>
<td>50</td>
<td>17 Jul 1871</td>
</tr>
<tr>
<td>Cook</td>
<td>Mrs. F. Wood</td>
<td>60</td>
<td>17 Jul 1871</td>
</tr>
<tr>
<td>Butler</td>
<td>Mr. R. Pegg</td>
<td>50</td>
<td>17 Jul 1871</td>
</tr>
<tr>
<td>Lecture R. M. Messenger</td>
<td>Mr. J. Dobson</td>
<td>24</td>
<td>20 Jul 1871</td>
</tr>
<tr>
<td>Servant</td>
<td>Mr. Farrell</td>
<td>18</td>
<td>28 Jul 1871</td>
</tr>
<tr>
<td>Servant</td>
<td>Mr. H. Doogan</td>
<td>18</td>
<td>28 Jul 1871</td>
</tr>
<tr>
<td>Servant</td>
<td>Mr. R. Chambers</td>
<td>18</td>
<td>1 Jul 1871</td>
</tr>
<tr>
<td>Servant</td>
<td>Mr. F. Oliver</td>
<td>18</td>
<td>1 Aug 1871</td>
</tr>
<tr>
<td>Servant</td>
<td>Mr. H. Vokings</td>
<td>18</td>
<td>2 Aug 1871</td>
</tr>
<tr>
<td>Boot Cleaner</td>
<td>Mr. M. Ferguson</td>
<td>18</td>
<td>18 Jul 1871</td>
</tr>
<tr>
<td>Housemaid and Linen Woman</td>
<td>Mrs. C. Dobson</td>
<td>12</td>
<td>24 Jul 1871</td>
</tr>
<tr>
<td>Cook's Assistant</td>
<td>Mrs. M. Doogan</td>
<td>10</td>
<td>28 Jul 1871</td>
</tr>
<tr>
<td>Cook's Assistant</td>
<td>Mrs. Fergusen</td>
<td>10</td>
<td>18 Jul 1871</td>
</tr>
</tbody>
</table>

¹ Salary in addition to military pay of rank.
² In addition to residence unfurnished, fuel and light.
³ Salary payable for first year £200.
⁴ Salary payable for first year £150.
⁵ Formerly Bailiff on the Estate and had a residence.

In addition to Board and Lodging.
Opening of the new College

Chesney's conception of a College designed specifically to place the profession of civil engineering on a firm scientific basis supplying the I.P.W.D. with highly qualified recruits had at last reached fruition. Conceived in the strictest sense in the interests of India its pregnancy was marked by considerable difficulties not least of which was the opposition from vested interest groups but when the moment of birth had arrived and the College was formally inaugurated on Saturday, the 5th August 1871, the occasion was undoubtedly a pleasing one for Chesney. His critical role throughout and his unquestionable access to the 'emperors ear' are typified by his suggestion to Argyll in July 38 that at the opening ceremony Argyll should focus attention on the reasons for establishing the College whilst he (Chesney) would comment on the special objectives which Cooper's Hill would aim to achieve, combined with a general exhortation to diligence and good conduct, thus avoiding any overlapping.

The opening ceremony was attended by approximately 200 guests (including staff and students) who had been conveyed by a special train from Waterloo to Egham station and thence in a fleet of horse-drawn carriages to Cooper's Hill. The guests included Sir Stafford Northcote (late Secretary of State for India) and Mr. Herman Merivale (Under Secretary of State for India) and the following Members of Council: Major General Sir W.E. Baker; Vice President, Mr. R. Mangles; Sir H. Montgomery; Lieutenant General Sir R. Vivian; Mr. Arbuthnot; Sir R. Montgomery and Sir H. Rawlinson. Noticeable amongst the other guests were Sir Edward Ryan, Chairman, Civil Service Commissioners; Sir Duncan Cameron, Governor of Sandhurst; Major-General Napier, Director-General of Military Education;
Colonel Hamley, Commandant Staff College; Juland Dawers, Director of Indian Railways; Lieutenant Colonel Strange, Inspector of Scientific Instruments Indian Store Depot; W.T. Thornton, Secretary I.P.W.D.; Sir Digby Wyatt; and, from the I.C.E., Charles Hutton Gregory (Past President) and the following members: E. Woods, C.E.; W. Parkes, C.E., and G. Preston White, C.E.

In his address to the assembled guests the Duke referred to the great public works then under construction, and those recently completed (in India), and the consequent need to maintain a permanent staff of military and civil engineers in India. After referring to the failure of the competitive system introduced by Lord Stanley in 1859, Argyll then commented on the want of proper means for engineering education in Britain and quoted extracts from the recently published enquiry into engineering education in Britain and Foreign Countries by the I.C.E. to support this view. In an attempt to placate any latter-day Fawcetts he also emphasised that the College was no close monopoly but was open 'to all the world', and his speech aimed at justifying the establishment of the College was followed by Chesney who proceeded to explain the course of study to be pursued at Cooper's Hill.

If the College was to achieve a reputable place in the education world Chesney emphasised that a high standard would have to be set from the start and that the rule would be hard work for all. "Cooper's Hill must not be an institution distinguished by a few brilliant scholars while the mass frittered away their time in idleness or amusement".

Although Chesney recognised the value of a good liberal education he stressed that Cooper's Hill would be an entirely
professional College embracing such 'utilitarian' subjects as Drawing, Surveying, Mathematics, Mechanics and the Principles of Construction. In emphasising that education should not stop there, he noted that the peculiar circumstances of work in India rendered a knowledge of the experimental and natural sciences invaluable to the practising engineer concerned with the conversion of raw materials. Thus, the Indian engineer, unlike his British counterpart, had to go direct to Mother Nature for his materials, to dig and burn his own lime, to make his own bricks and to fell his own timber. In these circumstances a knowledge of the chemical principles involved in the composition of mortars and cements was especially useful; so too was a knowledge of the principles which guided him to the places where suitable stones were to be found (geology and mineralogy). In a highly entertaining simile Chesney recognised that many engineers had learned by experience to distinguish between a good and a bad lime without knowing anything about carbonates or oxides, and that in the fullness of time, they "by a sort of instinct" learned where to dig for a good brick earth, "just as, by instinct, a pig was guided where to grub for truffles" 42 - but that type of ability was generally acquired very dearly by his employers.

To advocates of a practical training for a practical profession he noted that when a man's active life was to be passed entirely in practice it was not unreasonable to ask that two or three years should be devoted to preparatory study. Indeed the importance of a preparatory scientific education was more accentuated for the engineer in India where opportunities of 'making up for lost time' were not as abundant as those in Britain.

In support of the study of the Language and History of
India, Chesney argued that without them, an engineer would become alienated from the thoughts and feelings of the Indian people, and proclaimed "those who knew the people of India best esteemed them most" and conversely, those persons most pronounced in their contempt for "the natives" generally knew nothing whatever about them.

Finally, although timetable constraints at Cooper's Hill would not permit the study of Classics, modern languages or philosophy and indeed permitted only a partial range of natural sciences, these conditions should lead to humility rather than conceit as it was fundamental for the students to recognise that they were attending Cooper's Hill, not to be educated, but to begin their education by being set on the right road for pursuing it.

Chesney completed his speech by observing that Cooper's Hill had no traditionary influences of accumulated honour or historic prestige to guide the students conduct in academic and moral affairs. "Gentlemen", he declared, "if it be a great thing to belong to a family descended from a distinguished ancestor, it is still greater to be the distinguished founder of it", and, by establishing a high tone at Cooper's Hill its future success, in the inspired words of the poet, was secure:

"On Cooper's Hill eternal wreaths shall grow While lasts the mountain or while Thames shall flow." The proceedings were then concluded with a lunch provided for the visitors and students in the Dining Hall.

Although it was originally intended that the first term's work should commence in the week following the official opening, the building work was not sufficiently advanced to permit this, and, in consequence, the students were granted travelling expenses to attend the opening ceremony.
The following plan of the ground floor of the College is reproduced from "The Builder" (5th August 1871) and shows in the lighter shade from "Still room" to "coals" the section raised by two stories - the remainder of the shaded portion being entirely new. Accommodation within the College was provided for the President and his family, one married Professor and his family (Wolstenholme), three unmarried Professors, the steward, one hundred students (each with a separate room), and the College servants. In addition to the alteration of the mansion and the erection of a new block, five residences for professors were also under construction on the estate (one single and four semi-detached houses) together with considerable alterations to the stable block to adapt it as residences for married servants.

Many of the guests at the opening ceremony were clearly impressed with the site and structure of the College, and it is noteworthy that the principles which determined the establishment of the College were accepted uncritically by the invited reporters. Thus the "Times" recorded "nothing can be prettier in its way than the site of the College, famous as the scene of Denhams poem, and overlooking from its beautifully wooded slopes Windsor Castle, the Thames and parts of four or five counties". The "Spectator" and "Daily News" confined themselves to reports of the inaugural speeches whereas the technical press specifically welcomed the new institution. "We have from the first expressed ourselves strongly in favour of the establishment of this College" declared Engineering and "The Engineer" had the pleasure of recording its formal inauguration and added "we have on so many previous occasions expressed our concurrence with the soundness and justifiable character of the views which have..."
induced the Indian authorities to seek through a new channel for that which they were unable to obtain by the old". 49

In fact the "Engineer" had proclaimed in an editorial on the 6th January 1871 50 that "the course of action they (the Indian Government) have been obliged to pursue is a bitter, but at the same time a just, reflection upon the wretchedly inefficient condition into which our technical and professional education and training have fallen". The editorial concluded that "the only true method of raising the tone and prestige of a profession is by raising the standard of education of its members; and no one will deny that there is plenty of room for improvement in both of these particularly among engineers".

In consequence when reviewing the inaugural speeches "The Engineer" noted "it was impossible for any one to listen to the Duke's speech without feeling that it reflected gravely upon the educational status of the profession; and it was equally impossible to prevent a sense of shame that, however unpalatable his words might be, there was a considerable degree of truth in them". 51

Finally, a note of dissention was recorded by "Engineering" on the staff of the College, as, "the Royal Engineers have secured to themselves already a very fair proportion of the good things of the College, and probably we shall find, when the staff is brought up to its full complement a few more Royal Engineers added to the number of the professors". The journal added that these remarks were not generated by any spirit of hostile criticism but rather doubt as to whether professional duties were "the proper occupation for the members of that corps". 52
Cooper's Hill at work

The College opened for business on the 12th September 1871 when 49 students joined and the following day the regular work of the term commenced. Of the 50 competitors who were successful at the preliminary examination, five had withdrawn - two without assigning any reason (numbers 10 and 18 in the list), two had also gained places at the entrance examination for Woolwich and elected to enter that College instead (numbers 5 and 25), and one, number 46, was a successful candidate at the July examination for direct appointments to the I.P.W.D. (which continued to be held until the first batch of Cooper's Hill men left in 1874).

Because of these vacancies the candidates numbered 51 - 55 in the list were allowed, with the permission of the Secretary of State, to enter the College and thus complete the complement of 50 students. However, within a few days of opening in September, another successful candidate (number 37) sent in his resignation and indicated at the same time his intention of entering for the final examination in 1874, and this vacancy was not filled.

The College Regulations exhorted students to attend punctually at all lectures and to make detailed notes on the lectures delivered. These notes were subject to occasional scrutiny by the lecturer and any marks assigned were to be added to the marks attained in the College term examinations.

Facilities at the College included a Library and a Reading Room which were open from 9.00 a.m. to 11.00 p.m. although books could not be borrowed from the Library except from 2.45 p.m. to 4.00 p.m. when the Librarian would be present to record the issue. The Library had a large collection of books from the old Haileybury library and although works on engineering
were rather sparse it is noteworthy that the Library contained the proceedings of both the I.C.E. and I.M.E. together with the Roorkee Manual of Civil Engineering and Professor Rankine's works on "Machinery and Millwork", "Civil Engineering", "Applied Mechanics", "Steam Engine", "Useful Tables and Rules" as well as Airey's Lectures on Electricity and Magnetism.

Other facilities included the College Laboratory (which contained twelve working places) and the College Workshop (which contained a good collection of Lathes). Both were open daily from 3.00 p.m. to 6.00 p.m. and students wishing to enter the Laboratory and Workshop (optional) courses were required to register with Professor McLeod or Professor Reilly respectively, when the days were then fixed for each to make use of the facilities. A billiard room was also provided, open from 2.45 p.m. to 11.00 p.m.

The daily routine at Cooper's Hill included morning prayers at 9.00 a.m. in the Lecture Theatre followed by breakfast which was served between 9.00 a.m. and 10.00 a.m. Luncheon was at 1.00 p.m. and dinner at 6.30 p.m. followed by tea or coffee served in the dining or billiard rooms. The College Regulations noted that wine could be had from the College Cellar at the priced Tariff and any profit derived from wine sales would go to form a wine fund at the disposal of the members of the College. All accounts for wine or 'extra charges' such as bringing friends to dine in the hall (for which the charge was 1s. and 10d. per head) were required to be paid monthly.

Students were required to wear academical dress at all lectures, and in all the public rooms and when attending the special church service which Chesney had arranged for the
College at the Local Church, St. Jude's in Englefield Green, at 9.00 a.m. each Sunday. Each student was allocated a 'personal tutor' (each tutor had about 10 personal students) to advise and consult on academic or personal problems, and to whom they should report if wishing to be absent from the College on Saturday evenings or on Sundays - and indeed even if absenting themselves from the Hall at dinner times. Smoking was forbidden in any of the public rooms or corridors on the ground floor and the use of fire-arms was prohibited within the College premises. Finally as if to emphasise the socially exclusive nature of the College, the Regulations also "particularly requested that no gratuities may be given to any of the servants". 54

The timetable of the first year at Cooper's Hill was formidable covering a total of 42½ hours of instruction per week. Most of this was in the form of lectures, which, in the case of Experimental Science and Engineering were normally delivered in the Lecture Theatre to the whole of the students collectively. For other lectures such as Mathematics and drawing work the students were distributed in two divisions of twenty-four and twenty-five students each whilst surveying work was carried on in sections of twelve or thirteen each. It was envisaged that every section would be employed for one day in the week in Surveying and, if the weather permitted of field work, the hours of attendance for surveying were from 10.00 a.m. to 4.30 p.m. with a break for lunch. The two divisions were timetabled fortnightly at the end of which time the divisions alternated and this process of interchange continued throughout the year to ensure that the time allocated to each subject was the same for both divisions.

When faced with the following timetable many of the
students must have reacted with trepidation, but all quickly settled down to the actual work of the term.

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.45am to 9.00am</td>
<td>GD M M M</td>
<td>E E S GD</td>
<td>H H M M</td>
<td>GD E E</td>
<td>GD H H</td>
</tr>
<tr>
<td>9.00am to 1.00pm</td>
<td>GD GD GD</td>
<td>M S GD CD</td>
<td>S M H H</td>
<td>M GD GD</td>
<td>M GD GD</td>
</tr>
<tr>
<td>1.30pm to 2.45pm</td>
<td>M GD S</td>
<td>M S E E</td>
<td>M H H M</td>
<td>E S GD</td>
<td>M M M M</td>
</tr>
<tr>
<td>8.00pm to 9.30pm</td>
<td>Experimental Sc.</td>
<td>Engineering</td>
<td>Experimental Sc.</td>
<td>Engineering</td>
<td>Engineering</td>
</tr>
</tbody>
</table>

Key:
- E: Engineering
- M: Mathematics
- S: Surveying
- GD: Geometrical Drawing
- FD: Freehand Drawing
- H: Hindustani

Afternoon surveys continued until 4.30 p.m. when weather permitted fieldwork.
The total distribution of time per week was thus:

<table>
<thead>
<tr>
<th>Divisions</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Mathematics</td>
<td>$8\frac{1}{2}$</td>
<td>$8\frac{1}{2}$</td>
</tr>
<tr>
<td>Engineering</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Surveying</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Geometrical Drawing</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Freehand Drawing</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Experimental Science</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hindustani</td>
<td>$5\frac{1}{2}$</td>
<td>$5\frac{1}{2}$</td>
</tr>
<tr>
<td>TOTAL HOURS PER WEEK</td>
<td>$42\frac{1}{2}$</td>
<td>$42\frac{1}{2}$</td>
</tr>
</tbody>
</table>

Although the academic courses for the first term were extremely well organized, the College was not devoid of teething difficulties. Within a month of opening the drawing stools were found to be "of such a flimsy construction that they are falling to pieces" and were "quite useless for the purpose for which they are needed".56 The water supply caused considerable difficulties as did the ventilation system in the lecture rooms. The hot water pipes were found to go through the wine cellar "rendering the cellar useless for the storing of wine" as "the cellar was found to be quite an oven".57 Equally, because of the variable gas consumption at different times of the evening, the lights in the students rooms were found to often "flare up suddenly during their absence to quite a dangerous height".58 However as the contractors men were on hand throughout the first and second terms, these difficulties were soon resolved.

More fundamental difficulties were experienced with the academic courses themselves. The College Regulations had provided for monthly examinations to be held throughout the
term, in the subjects which had been read during the month; the marks gained to be included in those recorded at the examination at the end of the year. In addition examinations were held at the end of each term, the object being to test the student's knowledge and progress at every point of the College course.

By the end of the first term it was apparent that the character of the entrance examination had two basic defects. Firstly as a test of general education it could not guarantee that the men who gained a reasonably good percentage also possessed the necessary intellectual qualities to undergo a course of technical training. The result of the first term's examination revealed that one student came bottom in all four branches and was such an "egregious failure" that Chesney recommended his immediate withdrawal from the College. However, on appeal from the student's friends he allowed the student to return for a further trial period, but by the Spring Term examination Chesney had noted, "on the whole it appears doubtful whether some of those at the bottom of the list will succeed in qualifying for the public service, or even in passing the preliminary examination at the end of the first year, which entitles students to enter on the second years' course of study".

Nevertheless the President was convinced that if Cooper's Hill was to succeed and establish itself in the educational world, there could be "no relaxation or evasion of prescribed test, or doing anything that would tend to make that test a sham, or lower the high standard of qualification which we set out by aiming at". Indeed any failures in Chesney's view were more attributable to a want of energy and diligence during the hours of obligatory study, rather than to any
inherent defect in the entrance examination; the corollary of this was that he attributed successes mainly to persistent effort and almost excluded any propensity for scientific or technical work. In consequence he continually urged students to vigorous exertions, reinforced by approximately seven hours of compulsory study per day for six days a week (exclusive of revision and the laboratory and workshop courses).

The second, and related, defect of the entrance examination was that it guaranteed that successful candidates who entered the College and managed to scrape through the College course were awarded precisely the same class of appointment as those who passed the College examinations at the head of each list. Hence there was little incentive to industry — a defect which was further compounded by the fact that the marks gained at the term or minor examination could not count towards the final examination.

By the end of the first year the student at the bottom of the list had not made any further progress and he was removed from the College, whilst at the other extreme, one student succeeded in passing directly into the I.P.W.D. after a one year course. Thus 47 students went forward to the second year whilst the 1872 entrance examination provided 49 new students.

During the latter part of the first academic year the staff was strengthened by the addition of a Professor of Applied Mathematics, and, at the beginning of the second academic year was further augmented by the appointment of a Professor of Hydraulics and Mechanics and one instructor each in 'Surveying' and 'Geometrical and Architectural Drawing'. This brought the full establishment to eleven of whom two were non-resident, five occupied houses within the College grounds and four had quarters in the College buildings. In addition Dr. Martin Duncan,
recently elected Professor of Geology at King's College (1870), delivered a course of thirty-six lectures on geology and mineralogy in the first academic year and was engaged on a contract basis (for a total fee of 200 guineas per year) to continue this arrangement.

The Applied Mathematics post went to another Cambridge man who had been a candidate for the pure Mathematics post the previous year. A man of "most courteous and unassuming bearing", Alfred George Greenhill was a Fellow of St. Johns and Mathematical Lecturer at Emanuel College who had graduated as Second Wrangler in 1870 and had been bracketed equal with the Senior Wrangler for the Smiths prize. Indeed it is noteworthy that when Chesney offered him the appointment he hoped it would be "congenial to your own taste for scientific research", a sentiment which was equally applicable to the nominee for the Chair of Hydraulics and Mechanics, William Cawthorne Unwin. Originally it was intended that there would be one Professor on £700 per annum and one Assistant on £450, but when Professor Reilly was nominated to the first post he urged the separation of duties into two distinct appointments and was anxious that a man of Unwin's accomplishment should be given a full Professorship. Unfortunately it was impossible at that stage, to offer Unwin the increase in salary but he nevertheless accepted the chair as it was plainly compatible with his passion for research and his desire for further teaching experience. At 34 years of age, Unwin was well known throughout the civil and mechanical engineering world partly as Sir William Fairbain's assistant but more importantly for his investigations into the strength of materials and his book "Wrought Iron Bridges and Roofs" published in 1869 the same year as his "Memorandum on the
Effect of Wind Pressure on Roofs. His teaching experience was acquired both at the Royal Engineering Establishment, Chatham, and at the School of Naval Architecture, and in the Spring and Summer terms of the first academic year at Cooper's Hill he had delivered a course of lectures on Applied Mechanics.

The post of 'instructor in Surveying' went to a military officer, Captain E.H. Courtney. Although Chesney would have preferred to appoint a Civil Engineer he found "the surveying part of civil engineering is looked upon by civil engineers as being quite a subordinate part of their work, and is made over to quite an inferior class of persons".66 The last appointment, that in architectural drawing, was filled by Thomas Henry Eagles who had undergone 'the usual training for the profession in an Architects Office'. However, he then entered himself as a student at Cambridge, won an open scholarship and obtained "a very good place among the Wranglers", 67 and later practised as an engineer. The staff/student ratio was therefore (when complete) one teacher to fourteen students (approximately).

Throughout the first academic year Chesney embarked on an extensive correspondence to seek patronage for the College in the form of scholarships and prizes which would act as an incentive to industry, and by June 1872 had the following prizes to be awarded: 68

**Engineering**
- three scholarships aggregating £120 tenable each for one year and financed by the Civil Engineers of the I.P.W.O.S (the beginning of the Cooper's Hill Endowment Fund). In addition, College prizes of books, for descriptive engineering, surveying, geometrical drawing and freehand drawing.

**Mathematics**
Experimental Science: The Argyll Scholarship of £30 presented by the Secretary of State and tenable for one year - open to students in the second year. Also College prizes for Chemistry and Geology it being provided that a prize "cannot be taken in conjunction with the scholarship".

Languages: One College prize (books or instruments) for Hindustani and one for the history and geography of India. Two years later Chesney himself contributed the "President's Prize" of £20 for proficiency in Indian History and Geography open to students in the second year.

By the beginning of 1873 it was evident that scholarships and prizes alone were not a sufficient inducement to industry as Chesney had identified "two kinds of idlers". The first were men of good ability who were certain of qualifying at the final examination and were not worried about getting a mediocre result as all the appointments carried equal value. Hence, he suggested that students should have their choice of Province (in India) on first appointment to the I.P.W.D., to the extent of places available according to their place in the class list. The second class of "idler" consisted of the two or three men at the bottom of the list of whom it could not be predicted that they would definitely fail at the final examination but who undoubtedly ran a risk of so doing. For these he noted that "we never cease to whip up the laggards as strenuously as we can", and that the example of the expulsion at the end of the first year had a beneficial effect on these. Chesney considered that "the laggards illustrate the gambling spirit innate in some people by recklessly staking the love of pleasure against their future success in life". Nevertheless the term examinations remained of little incentive, for as long as persons prepared otherwise than at Cooper's Hill were eligible to present themselves at the final examination, the marks gained could not be cumulative and a 'course credit' system excluded.
Educational Antecedents of Students

The following table shows the total number of students who actually entered Cooper's Hill in the first ten years.\(^71\)

**TABLE XII**

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1871</td>
<td>49</td>
<td>1876</td>
<td>46</td>
</tr>
<tr>
<td>1872</td>
<td>49</td>
<td>1877</td>
<td>41</td>
</tr>
<tr>
<td>1873</td>
<td>48</td>
<td>1878</td>
<td>47</td>
</tr>
<tr>
<td>1874</td>
<td>50</td>
<td>1879</td>
<td>37</td>
</tr>
<tr>
<td>1875</td>
<td>48</td>
<td>1880</td>
<td>23*</td>
</tr>
</tbody>
</table>

An analysis of the places at which the 435* entrants were educate immediately prior to entering the College reveals the following sources.

**TABLE XIII**

Previous education of Cooper's Hill students (1871-1880)

<table>
<thead>
<tr>
<th></th>
<th>1871</th>
<th>1872</th>
<th>1873</th>
<th>1874</th>
<th>1875</th>
<th>1876</th>
<th>1877</th>
<th>1878</th>
<th>1879</th>
<th>1880</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>4*</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>37*</td>
</tr>
<tr>
<td>Public School</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>9</td>
<td>4</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>73</td>
</tr>
<tr>
<td>Grammar &amp; Proprietary School</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Pupilage</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Crammer</td>
<td>27</td>
<td>32</td>
<td>30</td>
<td>32</td>
<td>38</td>
<td>26</td>
<td>26</td>
<td>27</td>
<td>22</td>
<td>12</td>
<td>272</td>
</tr>
<tr>
<td>TOTAL</td>
<td>49</td>
<td>49</td>
<td>48</td>
<td>50</td>
<td>48</td>
<td>46</td>
<td>41</td>
<td>47</td>
<td>37</td>
<td>20</td>
<td>435</td>
</tr>
</tbody>
</table>

Thus, 36 students entered direct from University, three from pupillage with a civil engineer, one from the Royal Naval College, 73 from one or other of the major public schools, 50 from other schools (i.e. grammar and proprietary) and 272 from private tutors or crammers.

* The total for 1880 includes three students who had failed to pass the previous year's course (Devenish, McMillan and Stanbey).
+ The analysis of places of previous education for that year therefore includes only twenty students.
+ Includes one student from the Royal Naval College.
The term "crammer" was largely a pejorative term used by public school masters to describe private tutors and coaches. The ubiquitous emergence of crammers in the 'eighteen-sixties' and 'seventies' was largely due to a fundamental shift from a system of aristocratic privilege and patronage to one of 'meritocratic' open competitive examinations in both the Universities and the Home and Indian Civil Services. Open competition in the I.C.S. was introduced as early as 1855 and indeed by 1871 all entry to army commissions was by this method. However, the public schools were relatively slow to adapt their institutions to the changing circumstances and a clear need emerged for intensive teaching before taking the new competitive examinations, which was met by the private tutor or crammer.

In order to evaluate the relative success of crammers in preparing pupils for the Cooper's Hill examination it would be necessary to analyse the educational antecedents of all competitors, but the analysis of those successful at least indicates an overwhelming emphasis on cramming immediately before taking the entrance examination. In this respect the experience of A.S.M. Ritchie would appear typical: "I passed the Woolwich examination straight from school, Charterhouse, chiefly on languages, but I was sent to a crammers for four months before going up for Cooper's Hill, as I did not know enough Mathematics to be sure of qualifying".

The following are the names and addresses of some of the more notable crammers who prepared candidates for Cooper's Hill in the period under review and who were active in the London area.

Rev. J.M. Brackerbury and Rev. C.J. Wynne of Wimbledon
Rev. C.F. Coutts, M.A., 23 Colville Terrace, Kensington Park
D.C. Feery, B.A., 14 Cambridge Gardens, Notting Hill
Rev. Dr. C. Hughes, M.A., L.R.D., Castlebar Court, Ealing
W.C. Northcott, M.A., Rochester House, Ealing
C.R. Rippin, M.A., Military College, Woolwich
Rev. W.B. Scoones, Carrick Chambers, Garrick Street, W.C.
Rev. W. Wren, M.A., 4 and 5 Powis Square, Notting Hill.

The extent of their operations varied considerably. The Rev. Charles Hughes was a Cambridge Wrangler who prepared twelve students per annum for either Woolwich and the Line, The Control, Cooper's Hill or the Indian Civil Service and the Universities and indeed he provided a successful candidate at the first entrance examination in 1871. The fees at Castlebar Court were 140 guineas per annum and pupils were timetable from 9 a.m. to 1 p.m.; 4 p.m. to 5 p.m.; 5.20 p.m. to 7.20 p.m.; and 9 p.m. to 10 p.m. for five days and on Saturdays from 9 a.m. to 12 noon.75

Two of the most successful crammers for Cooper's Hill were W. Baptiste Scoones and Walter Wren. At Garrick Chambers, Scoones boasted of a small chemistry laboratory and later a laboratory for Electricity and Magnetism. He also provided a club room and a library of more than a thousand books of reference. Wren on the other hand was acclaimed the "King of the Crammers" and his pupils claimed almost 50% of the places in the I.C.S. during the period 1873-1879 (118 out of 237). Indeed his establishment was commended in the Blue Book of 1876 "The Selection and Training of Candidates for the Indian Civil Service" as well as the 20th Report of the Civil Service Commissioners.

The apparent success of crammers over public schools may be attributed to their elasticity, their economy in the distribution of subjects, their economy in the distribution of time, their powerful motives for exertion and their atmosphere of mental activity.76 In this context Winston Churchill's oft quoted view of cramming as the "renowned system of intensive poultry farming" 77 provides an interesting perspective. In his autobiography, "My Early Life", Churchill notes that he failed twice
to get into Sandhurst from Harrow and was then sent to the South Kensington firm of crammers known as Captain James and Partners. Of James' establishment it was noted that,

"no one who was not a congenital idiot could avoid passing thence into the Army. The firm had made a scientific study of the mentality of the Civil Service Commissioners. They knew with almost Papal infallibility the sort of questions which that sort of person would be bound on the average to ask on any of the selected subjects. They specialised on these questions and on the answering of them. They fired a large number of efficient shotguns into the brown of the convoy and they claimed a high and steady average of birds ... Thus year by year, for at least two decades he held the Blue Ribbon among the crammers ... No absolute guarantee was given, but there would always be far more than a sporting chance."

Similarly in the case of Coopers Hill no guarantee was given but many of the crammers enjoyed considerable success, and consequently earned substantial incomes. They emerged in an age of so-called "open-competition" to fill a demand for short intensive courses, which, for many people, resulted in a delusive show of talent. Thus in a Leading Article in 1876 "The Builder" referred to "the excellence of the College course of study" (see below) but declared "it is impossible not to feel that the preliminary examination presided over by the Civil Service Commission is redolent of coaching, cramming, and every unnatural appliance to force frail humanity in that part of it which is worth very little indeed until after long and gradual development". Later in the article the Editor referred to "that kind of 'fiddling' which succeeds by chance at a competitive examination, but which shows in the player neither sterling qualities nor special talent". However, the principal grievance of "The Builder" was against the inclusion of classical languages in a test for entry to an Engineering College. "The power of rendering long passages from Cicero, Tacitus, Horace, Ovid and Statius into pure English ... is an eminent acquisition to the wealthy scholar or a well-to-do bookworm ... (but) is anything
but indispensible to an engineer student". 80

The reality of the entrance examination was, however, that classics and modern languages were included as a test of a good general education, but greater emphasis was placed on the 'modern' science based subjects as one of the early Cooper's Hill students reflected in somewhat biased lyrics 81 :-

P.W.D.

"When I was a lad I was sent to school,
To be taught Mathematics by the best and newest rule;
I spurned Greek and Latin with contempt sublime,
And to modern subjects only thought of giving up any time;
I worked at those subjects so carefully,
That now I am a member of the P.W.D.

At Euclid and Arithmetic I made such a name,
That the head of my school I soon became.
To riot or disturbance my aid I never lent,
But in scientific studies all my leisure moments spent;
And these scientific studies did so well for me,
That now I am a member of the P.W.D.

I rushed through Mathematics at a pace so fast,
And my parents thought that Medicine, the Church, and the Bar,
For such talents offered openings too small by far;
So they finally decided that it best would be,
To make me a member of the P.W.D.

At a cramers in Town some months I spent,
Then up for the open competition I was sent;
I floored every paper, not a question I missed,
And when the marks were published I was first in the list
And the top of the list so suited me,
That now I am a member of the P.W.O.

Towards the end of the century 'cramming' began to decline dramatically as public schools reorganised their classes by providing a 'modern' side. This effective opposition resulted in both a substantial reduction in the number of crammers and a corresponding reduction in 'cramming' as a method of entry to Cooper's Hill.
Curriculum

The curriculum pursued by the students at Cooper's Hill is noteworthy both in its structure and in illuminating the state of professional knowledge in the early 1870's.

The following table, extracted from the first syllabus published in 1871, shows the distribution of marks to be allotted in the final examination at the end of the third year's course, and the minimum marks required for qualification in each of the different subjects of study. This table, in addition to showing the relative weighting given to the four different branches of study, will also be used to illustrate the content of the different courses.

**TABLE XIV**

<table>
<thead>
<tr>
<th>Branch</th>
<th>Subject</th>
<th>Qualifying minima</th>
<th>Maxima obtainable</th>
<th>Extra subjects optional</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>I ENGINEERING</td>
<td>Descriptive Engineering</td>
<td>18</td>
<td>45</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Surveying</td>
<td>12</td>
<td>30</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Architecture</td>
<td>3</td>
<td>8</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Geometrical drawing and estimating</td>
<td>14</td>
<td>42</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Accounts</td>
<td>2</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Freehand Drawing</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>49</td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Notes and reports</td>
<td>5</td>
<td>20</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>I ENGINEERING</td>
<td>Project</td>
<td>10</td>
<td>24</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>II MATHEMATICS</td>
<td></td>
<td>15</td>
<td>44</td>
<td>-</td>
<td>44</td>
</tr>
<tr>
<td>II MATHEMATICS</td>
<td>TOTAL</td>
<td>64</td>
<td>174</td>
<td>80</td>
<td>254</td>
</tr>
<tr>
<td></td>
<td>Pure and applied Mathematics</td>
<td>9</td>
<td>36</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applied Mechanics</td>
<td>9</td>
<td>36</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>18</td>
<td>72</td>
<td>60</td>
<td>132</td>
</tr>
<tr>
<td>Branch</td>
<td>Subject</td>
<td>Qualifying minima</td>
<td>Maxima obtainable</td>
<td>Extra subjects optional</td>
<td>TOTAL</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>-------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>III NATURAL SCIENCE</td>
<td>Experimental science, Geology and Mineralogy</td>
<td>10</td>
<td>30</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>10</td>
<td>30</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>IV LANGUAGES</td>
<td>Hindustani and History and Geography (including physical geography) of India</td>
<td>8</td>
<td>24</td>
<td>-</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Latin (2 only to be taken)</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Greek</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>French up, less than 6 marks in any subject not to count</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>8</td>
<td>24</td>
<td>30</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>GRAND TOTAL</td>
<td>100</td>
<td>300</td>
<td>200</td>
<td>500</td>
</tr>
</tbody>
</table>

In order to qualify for the Public Works Department it was necessary for candidates to obtain not only the minimum marks fixed in each subject, but also to obtain not less than 150 marks in all the subjects taken together. However marks gained in the optional subjects were included in this aggregate.

At the final examination students were distributed in three classes, in each of the four branches of study into which the course was divided, their names being recorded in each class in order of merit. Moreover, the requirement to qualify in every subject would be dispensed with in the case of any students placed by the examiners in the first class in both Engineering and Mathematics.

Final examinations were conducted partly by means of
written papers and partly viva voce, and also included exercises in surveying, drawing, estimating and designing which occupied several weeks in execution. However, in order to understand the nature of the final examination it is necessary firstly to sketch in outline the structure of the third year's course and then to consider the content of the academic course separately.

The first two terms of the third year were spent as pupil to a civil or mechanical engineer during which time the students were required to keep a diary of their occupation and to take notes illustrated by sketches and drawings of the works on which they were engaged. Reports were then drawn up and eventually laid before the examiners who assigned marks on their completeness as well as to the clarity of the viva voce explanations given of them. Indeed it was emphasised to each student that they would not be considered qualified until the examiners were satisfied that they had made the best use of this opportunity for practical experience.

The concluding part of the course at Cooper's Hill, i.e. the last term of the third year, was devoted to project work, part of which was performed during the final examination. Thus, students were required to make a survey for a portion of road, railroad, or canal, through some district of country already surveyed in the neighbourhood of the College; to make a traverse and mark the needful levels with cross sections along the line selected; to lay down the line in plan and section; and finally to prepare a general estimate, including detailed drawings of one or more of the works to be undertaken with the calculations involved in the design.

Plainly this work, together with meaningful observations during the period of pupilage, required the application of
knowledge acquired throughout the first two years of the College course. This knowledge was based on the following outline of the four branches of study. The engineering curriculum was divided into descriptive engineering, surveying, architecture, geometrical drawing and estimating, accounts and freehand drawing.

Descriptive engineering was subdivided into four courses: (a) construction, (b) hydraulic engineering, (c) mechanism and prime movers and (d) the design and execution of structures. The course of construction focussed attention on the nature, production and uses of the materials of construction and began by classifying the materials of construction: i.e. solid materials (stone, brick, wood, metals), cementing materials (mortars, cements, mastics, glue) and protecting materials (plasters, paints, solutions of salts, bituminous substances). This was followed by an examination of the structure and chemical constituents of natural stones; classification of building stones, quarrying stones, bricks (including details of brick-making in the neighbourhood of London); brickmaking as practised at Nottingham and surrounding neighbourhood; description of Hoffman's kiln; terra cotta (colouring of bricks and tiles), and then an analysis and definition of limes, cements, mortars, concretes, plasters and mastics. The course on wood began with an examination of the structure of wood and the classification of timber: felling timber; seasoning timber; durability of timber; causes of decay and methods of preservation of timber. Similarly metal and alloys were commenced with definitions, composition and sources followed by the varieties and production of iron (especially cast iron, wrought iron and steel) and the durability, corrosion and preservation of iron. Masonry also began with definitions and then a consideration of
the mechanism for moving large stones, instruments used in building, mensuration of masonry, construction of stairs in stone and the specifications for stone in India. An integral part of this course was an understanding of the trades of bricklaying and tiling, carpentry, joinery, slating (including thatching with grass in India), glazing, plastering and painting. This course was concluded with a section on 'Earthwork' which examined the preliminary arrangements to be undertaken by the engineer such as the preparation of plan and sections, tenders, arrangements with contractors, embanking and puddling.

The course of hydraulic engineering focussed attention on the measurement, estimation and storage of water, followed by water channels (natural and artificial), systems of drainage, works of inland navigation, systems of water supply and irrigation and especially examined works of irrigation in India.

The course on mechanism and prime movers began with a description and construction of the elementary pieces of machines (couplings, clutches, wheels, driving belts, cranks, eccentrics, cams, connecting rods) and then looked in detail at the hydraulic prime movers (water wheels and water pressure engines) and at the steam engine (thermodynamical theory). The course also embraced an analysis of the machinery used for raising water including pumping machines, beam and bucket, Indian riot, Persian wheel, chain pumps, scoop wheels, Archimedean screws, Airey's improvements, spiral and centrifugal pumps, and water valves.

The fourth part of the descriptive engineering course, that concerned with the design and execution of structures, aimed to show how a knowledge of the theory of resistance of materials and of simple structures, and of the nature, properties and uses of materials, may be applied in the design and execution of combined
structures. This required a prior acquaintance with Applied Mechanics, as well as with many of the subjects in the other three parts of this course. Once again the course commenced with a classification of combined structures (foundation, buildings including large roofs, bridges, viaducts and aqueducts, tunnels, covered ways, roads, tramways, railways, sea defences, harbour works), followed by a detailed analysis of the design and execution of each combined structure but with particular reference to the state of the art in India.

The second major subject area within the field of 'Engineering' was surveying, and as this subject required considerable practical work it is best considered under three separate years. The first year's course introduced the students to the use of the instruments employed followed by chain surveying, a compass and chain survey and then levelling. In the second year students commenced a course on surveying with the theodolite and on the elements of practical astronomy. As mentioned above, the third year course embraced a project for a portion of road, railroad or canal, but this was combined with a lecture room course and drawings to illustrate the project, together with some practical astronomy.

Architecture on the other hand occupied only a one-year course of lectures on the history of architecture, descriptions of various styles, principles involved in designing and planning buildings and the elements of the art of house-building.

The subject geometrical drawing and estimating was taught partly by class lectures and partly by exercises performed under instruction. The course consisted of practical geometry, plane and solid geometry, perspective, architectural and constructional drawing, mechanical and engineering drawing and finally estimating.
Although the total marks obtainable for accounts formed less than four per cent of the total for engineering, the subject was treated with deference by the students partly because engineers in the I.P.W.D. spent a considerable portion of their time on accounts but also because the classes were taken by the President of the College. The course involved a study of the first principles of accounts, mercantile and banking accounts, accounts of the I.P.W.D. and especially of railway and irrigation works in India.

The curriculum in the second branch of study, Mathematics, consisted of pure and applied mathematics, together with Applied Mechanics. The pure and applied mathematics course embraced arithmetic and mensuration, algebra, trigonometry, analytical geometry, differential and integral calculus, integration, statics, dynamics and hydrostatics. The other half of the course (Applied Mechanics) focussed considerable attention on the theory of Resistance of Materials and Structures and commenced with general ideas and definitions relating to the strength or resistance of materials used in construction. This was followed by: resistance of straight pieces to simple longitudinal extension and compression, determination of specific constants, resistance to simple sliding of two contiguous sections of a prism, resistance of solids to flexure produced by external forces acting perpendicularly to their length, flexure combined with longitudinal extension or compression, resistance of prismatic solids to torsion and flexure combined, resistance of envelopes (cylindrical and spherical), theory of the composition and resolution of internal stress in a body (considered irrespectively of the corresponding deformation); the equilibrium, stability, and strength of frames; stability and resistance of suspension bridges;
continuous girders (theoretical difficulties and applications of plate and lattice girders); the theory of earth pressure (construction of ordinary foundations); resistance of blockwork structures, iron and timber arches. This course also included the 'theory of the flow of water', the theory of mechanism and examined the work of machines with uniform or varied motion.

The third major branch of study, Natural Science, was divided into (a) experimental science and (b) geology and mineralogy. 'Experimental Science', covered 'chemistry'—basic physical chemical principles with detailed treatment of the chemical properties of metals and non-metals; 'Magnetism', 'Frictional and Statical Electricity', 'Voltaic Electricity', 'Sound', 'Light' and 'Heat'. 'Geology and Mineralogy' included a consideration of the different schools of thought from 'uniformitarianists' to 'catastrophists' and 'evolutionists' and a study of glacial, volcanic and earthquake phenomena.

The course paid particular attention to the descriptive geology and palaeontology of the tertiary formations of England and India, especially the descriptive petrology of the commonest rocks of the Indian formations, and descriptions of the principal types of carboniferous and secondary floras of India.

Finally, the languages branch included Hindustani and History and Geography of India. The books used to teach Hindustani—from which the passages to be translated into English at the final examination were selected—were: "Tota Kahani"; "Bagh-o-Bahar" (first 150 pages); and "Baital Pachisi" (first 60 pages). The final examination also included questions on grammar and exercises in translation from English into Hindustani. History and Geography on the other hand was extremely broad and ranged from elements of Indian ethnology to
an account of the system of Indian administration, and included the physical geography of the country with some reference to its productive resources.
1. The Prospectus was revised by the end of March and Allen's Indian Mail noted joyfully that the Government had refused to yield to the "clamour of a party which, under the cloak of free trade principles, sought to maintain the vested interest of various teaching bodies in the right to furnish India with badly qualified civil engineers". The new regulations stipulated that "successful competitors who may be found on subsequent examination to be already qualified for the engineering service, will receive appointments without passing through the College". See "Allen's Indian Mail", Tuesday, 11th April 1871. See also "Engineering", Volume 11, 24th March 1971, pp.211-212.

(In reality candidates wishing to enter the I.P.W.D., but not to be educated at Cooper's Hill, were required to pass the entrance examination - within the top 50, continue their education elsewhere and then present themselves for the final examination at Cooper's Hill.)

2. 1OR/L/PWD/8/8 (Cooper's Hill Papers), p.191.

3. The original total allocated for Experimental Science was 750, but in view of representations from T.H. Huxley and others this total was increased to 2,000. Huxley argued "A scheme of examination for entrance into an Engineering College which gives 2,000 marks to Latin and Greek and 750 for Experimental Science ... deliberately throws obstacles in the way of the entrance of every man whose preliminary education has specifically fitted him for an engineer - And the adoption of such a scheme would be offering a direct inducement to public schoolmasters to stop short in that introducing (sic) science into schools which has already happily commenced". Letter from Huxley to M.E. Grant-Duff marked "Private" and dated Jermyn Street, 28th November 1870. This letter is reproduced in full in Volume 1 of Cyril Bibby's unpublished Ph.D. (London) thesis, 1955, entitled "T.H. Huxley : His Place in Education", p.145.

4. 1OR/L/PWD/8/8, p.189 gives details of the advertisement arrangements.

5. For a copy of the first prospectus see 1OR/L/PWD/8/8, p.291-295. Although the Prospectus is without date, potential candidates were supplied with copies during the last week in November 1870 and throughout the succeeding months.

6. Amongst those consulted were : Henry Cole (see esp. two Letters from Chesney to Cole dated India Office, 2nd December 1870 in 1OR/L/PWD/8/37, pp.105-106 and 107); Fleming Jenkyn, Macquern Rankine, and Dr. W. Pole at the I.C.E. as well as numerous military engineering colleagues.

7. The arrangements made for the first entry examination are described in 1OR/L/PWD/2/225 No.131 which contains a copy of the examination timetable.
8. "Engineering", Volume 12, 14th July 1871, p.27.

9. "Memo, as to the eligibility of an Estate at Cooper's Hill, Egham, for the proposed establishment for training engineers for the Indian Service" dated 27th October 1870, by Sir Digby Wyatt. Included in "Surveyors Reports", Volume 1OR/L/SUR/6A, pp.29-43.


12. Ibid.

13. Ibid, p.34. Additional students rooms were estimated to cost approximately £200 each.

14. See 1OR/L/PWD/8/8 "Memorandum as to Eligibility of Cooper's Hill", p.165.

15. Letter to Baron Grant's Agent, Mr. Blackmore, dated India Office, 11th November 1870. See "Copies of College President's Letters Out, 30th June 1870 to 12th May 1873", 1OR/L/PWD/8/37, pp.53-54.


17. Letter from Wyatt and Chesney to Messrs. Lawford dated India Office, 14th November 1970, in 1OR/L/SUR/6A, p.54. Baron Grant's Solicitors in this transaction were Messrs. West and King of 66 Cannon Street, City.

18. See 1OR/L/SUR/6A, pp.115-126.


20. 1OR/L/SUR/6A, p.125/126. This may be taken as further evidence of the speed with which the Duke of Argyll wanted the transaction completed.

21. 1OR/L/SUR/6A, p.135, "Cooper's Hill - Memo on its passing into the possession of the Secretary of State in Council", by Digby Wyatt dated 6th February 1871.

22. See "Estimate for College Furniture and Fittings" in 1OR/L/PWD/8/27, pp.76-81. See also "Furniture and Fittings for Civil Engineering College" in 1OR/L/PWD/8/8, p.473. A detailed inventory of the furniture provided in each of the students rooms is contained in 1OR/L/PWD/8/37, pp.82-83.

23. The livestock on the farm consisted of four cows from which it was intended to supply the College with milk and butter (1OR/L/PWD/8/8, p.483 and 1OR/L/PWD/8/27, p.200) but for details of the fittings purchased from Baron Grant see 1OR/L/PUD/8/27, p.85.

24. This final total includes the cost of building a gymnasium which was sanctioned by the Council of India - see Minutes of the Council, Jan.-June 1871, Volume C126, pp.582, 617 and 631. It is not clear whether it included the architect's (Digby Wyatt) or Surveyor's (Henry Gritten) fees of 5% and 2% respectively of the work completed.

26. Quoted in Cd.831 of 1901, p.11 (this was later taken to mean 'half a term's notice without cause assigned' - see infra Ch.6).

27. Letter from Chesney to Professor Fleming Jenkyn dated India Office, 5th December 1870, reproduced in 1OR/L/PWD/B/37, pp.108-110.

28. Ibid.

29. Chesney's requirements for this post were stated in a letter to Major Mullins, R.E., dated 13th September 1870. This letter concerns the Chief Engineer of the Madras Irrigation Company, Mr. Lathan, who had been suggested as a potential incumbent, (1OR/L/PWD/B/37, p.38-39). Lathan was originally proposed by Mr. Rendel, the Consulting Engineer to the East India Railway, (1OR/L/PWD/B/37, p.42) and was later invited - following Jenkins refusal - to apply for the post, 1OR/L/PWD/B/37, pp.113-116.


In a letter to Rankine, dated 1st March 1871, Chesney noted "I need perhaps hardly say that my nomination of that gentleman (Reilly) for the post was very much influenced by the favourable opinion of his qualifications you were so good as to favour me with". (1OR/L/PWD/B/8, p.236).

31. This letter relating the circumstances of his appointment was addressed to William Cauthorne Unwin and dated 3 Storeys Gate, Westminster, 4th April 1871, and is reproduced in "The Life and Work of William Cauthorne Unwin" by E.G. Walker (London 1938).

32. 1OR/L/PWD/B/8, p.308 : Letter of recommendation dated 14th February 1871 (op.cit. footnote 30).


34. Four of whom had Ph.D's. See 1OR/L/PWD/B/8, pp.314 and 317a.

35. See letter dated 'India Office, 9th March 1871' from Chesney to McLeod in 1OR/L/PWD/B/37, p.260.

36. See letter dated 'India Office, 10th February 1871' from Chesney to Edgecombe in 1OR/L/PWD/B/37, pp.205-206. Also 1OR/L/PWD/2/226, p.190.

37. Clarke later recalled the circumstances of his application, as it was entirely by coincidence that he heard of the
37. (continued) His position. He had recently completed his military training at Chatham when, in the summer of 1870, he went by train to London to attend his grandfather's funeral. By chance, his Commanding Officer at Chatham, Col. Charles C. Chesney, boarded the same train. At Surbiton Col. George Chesney got into the carriage and told his brother that he wanted a young R.E. officer to teach practical geometry and engineering drawing at the new College at Cooper's Hill, which he was establishing to meet the requirements of the I.P.W.D. I applied at once for the post but it fell to Lieut. (afterwards Colonel Sir) M. Ommondy, who almost immediately accepted another appointment leaving the reversion to me. "My Working Life" by Colonel Lord Sydenham of Coombe (London, John Murray, 1927) p.12.

38. This suggestion, to which the Duke of Argyll agreed, is contained in a note dated Cooper's Hill, 18th July 1871. "Argyll Papers".

39. The Inaugural Speeches of Argyll and Chesney can be seen at Shoreditch College, Brunel University (Cooper's Hill Society Papers).

40. "The education and Status of Civil Engineers in the United Kingdom and in Foreign Countries". Compiled from documents supplied to the I.C.E. between 1868 and 1870. In fact Argyll quoted Fleming Jenkyn's evidence; see infra. Ch.1, p.27.

41. Ibid (footnote 39).

42. Ibid.

43. Ibid.

44. Ibid.

45. Alexander Pope's tribute in "Windsor Forest" to Denham's poem "Cooper's Hill" (written in 1643). See the "Illustrated London News", 25th November 1871, for comment.

46. The Class Rooms at the College were later labelled after Secretaries of State, "Northcote", "Derby", "Argyll" and "Salisbury" whereas the four corridors were referred to by Governor Generals, "Hastings", "Dalhousie", "Cornwallis" and "Clive".


51. "The Engineer", 11th August 1871, p.94. In fact the Journal did not agree with the general charge of incompetence which was indirectly levelled at the profession by the Duke of Argyll's citing individual cases of incompetence (i.e. Jenkyn's evidence to the I.C.E. Report). However, "the impression left on the mind ... was that the usual course pursued by engineers in their professional and technical training, was utterly inadequate to turn out competent men".

52. "Engineering", 11th August 1871, p.93. In fact this Journal had been consistently in favour of the establishment of the College but was clearly desirous that it should become a truly civil engineering college rather than a further encroachment by the military into the civil profession.

53. The first set of "Regulations" (six pages) are included in 1OR/L/PWD/8/9 entitled "Private - Indian Civil Engineering College, Cooper's Hill, Regulations" and although without date they clearly relate to the (future) first academic year.

54. Ibid, Clause 17, p.3.


57. See the letter from Chesney to Mr. J. Gritten, dated 8th November 1871, 1OR/L/PWD/8/27, pp.491-493.

58. Ibid.

59. Letter dated 1st February 1872 (entitled Public Works Minute No.11) from Chesney to the Duke of Argyll. See 1OR/L/PWD/8/7, p.239.

60. Letter from Col. Chesney to the Under Secretary of State for India, dated 16th March 1872. See 1OR/L/PWD/8/7, pp.261-262.

61. Ibid, p.262. See also 1OR/L/PWD/8/37, pp.217-218.

62. 1OR/L/PWD/8/37, p.295.

63. Ibid.

64. The letter of recommendation from Chesney to the Duke of Argyll is dated 9th July 1872 (1OR/L/PWD/8/37, p.363) although Unwin was informed the previous year that the second appointment was his. For detail of Unwin's early education, teaching and research experience see "The Life and Work of William Cauthorne Unwin", by E.G. Walker (op.cit. footnote 31).

66. Letter of recommendation from Chesney to Argyll (in 1OR/L/PWD/8/37, pp.336-337) dated 5th June 1872.

67. Letter of recommendation from Chesney to Argyll (in 1OR/L/PWD/8/37, p.382) dated 9th July 1872.

68. See 1OR/L/PWD/8/7, pp.289-291, and 1OR/L/PWD/8/8, p.618.


70. Ibid, p.350.

71. Compiled from the annual returns made to the India Office at the beginning of each year, 1871-1880. For a comparison with later entrants (years: 1893-94; 1894-95; 1895-96) see the returns compiled in 1OR/L/PWD/8/350.

72. Unfortunately the educational background of the unsuccessful competitors was not retained at the India Office. Indeed those for the successful competitors had to be gleaned from a wide range of sources.

73. Letter in "Indian Engineering", 31st August 1889.

74. These are the firms whose names recur most frequently in the India Office Records. For greater detail as to the extent of their operations see D.P. Leinster - Mackay, "The English Private School, 1830-1914". Unpublished Ph.D. thesis, Durham University 1972, Volume 1, Ch.6. "Private Coaching and the growth of Competitive examinations".

75. Hughes' prospectus for 1877-1878 is included in Leinster - Mackay's thesis as Volume III, Appendix 20, p.211.

76. Henry Wolframs pamphlet "The Private Tutors raison d'etre" (1885) provides a carefully reasoned argument in favour of cramming.


78. Ibid.


80. Ibid.

81. This poem, signed 'Ego', was published in the College Magazine, "The Oracle" (March and April 1880, Volume VI, No.53) pp.651-652 (Cooper's Hill Society Papers).

82. The Syllabus was published by W.H. Allen. See "Tracts Relating to Education, etc.", BM.8365 bbb 44(4). The development of the curriculum may be extracted from the "Cooper's Hill Calendars", twenty-five volumes of which exist at the India Office (1OR/(67) 1928) from 1873-1874 to 1902-1903.
Financial Results

Throughout the first ten years, the College struggled to establish itself as one of the most complete establishments for civil engineering education in Britain, and to its credit the struggle was largely successful. On the debit side however, had to be set the financial burden which the College represented to the revenues of India.¹

In 1873 the College buildings had been extended by the erection of additional accommodation, to complete that required for 150 students, together with a College Chapel. Chesney had found the services at St. Jude's to be of a 'very dry, unedifying character' and held strongly that the Government should aim to send out to India men who were "not only good engineers but religious men, at any rate Christians in feeling and profession".² Not only were the 'men' at Cooper's Hill of an 'impressionable age' but without compulsory church service they "should have been sitting up till any hour on Saturday night, and lying in bed all Sunday morning". The Chapel expenditure was reluctantly sanctioned but it is clear that the inequity of applying Indian Taxation (from Mohammedons, etc.) for the purpose of Divine Service had not occurred to Chesney.

Additional expenditure had also been incurred in the first few years on a boathouse, gymnasium and the purchase of a piano and billiard table. Although a billiards room was specifically provided in the design of the College building, the College had commenced without such a table and Chesney noted "a room without a table would have surely been an inconsequential arrangement".³ The idea that expenditure of this nature might be objected to had also not occurred to him as it seemed perfectly sensible that he "could not risk the experiment of the College taking a
View of the Chapel (1900)
rowdy turn, which might very probably have been the result of turning the students into a room with bare walls and calling it a recreation room". Moreover, "if amusements were not provided here, we should have them frequenting all the low billiard tables in the neighbourhood" and with a hundred young men locked up together on a winter's night in a big house in the country, he wrote, "if the place is not to become a bear garden, it is absolutely necessary to provide means of rational amusement". Indeed the College very quickly established successful football, cricket and boat teams, a choir and a classical guitar club, but as the College Societies will be elaborated upon later in this Chapter it is necessary here to focus attention on the cumulative effect of the successive capital expenditure at Cooper's Hill. Indeed in his annual estimates of the cost of the College, Chesney was consistently reluctant to admit any debit on account of interest on capital expended. However the financial burden of the College was of deep importance to those, dispassionate persons, at the India Office who were unconcerned with the novel educational character of the institution.

General financial control of the College was exercised through a yearly budget which was submitted by the President for approval at the beginning of each financial year and outside the provisions of which no expenditure was allowed except under special sanction obtained from the Secretary of State in Council.

This special sanction was clearly necessary in the case of the initial capital expenditure and that required for the subsequent extensions but, by 1875/6, the total capital expended had amounted to £119,076, distributed thus:
<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase of the Cooper's Hill Estate</td>
<td>55,000</td>
<td></td>
</tr>
<tr>
<td>Stamp on conveyance</td>
<td>275</td>
<td></td>
</tr>
<tr>
<td>Fittings purchased from previous owner</td>
<td>1,000</td>
<td>56,275</td>
</tr>
<tr>
<td>Builders work and furniture (including the new wing in 1873-74)</td>
<td>50,079</td>
<td></td>
</tr>
<tr>
<td>Furniture</td>
<td>12,722</td>
<td>62,801</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>62,801</strong></td>
<td><strong>£119,076</strong></td>
</tr>
</tbody>
</table>

This massive expenditure contrasts sharply with Chesney's efforts at economy, but it did not escape the attention of the Home Government. The 'special sanction' was readily available when Argyll was Secretary of State but on the fall of Gladstone's Government in 1874 the interest on the capital expended had clearly not been defrayed by College receipts. In keeping with the Government of India's strictures that the Institution would be "distinctly condemned if it could not be conducted on what would be an entirely self-supporting basis" the new Secretary of State (Salisbury in his second term) soon held financial equilibrium to be the sine qua non of the College's existence. Indeed by 1876 it was abundantly clear that the receipts were not even covering the current expenditure, and, if interest on the cost of the buildings, fixtures and fittings, was added, nearly one-third of the total expenses remained to be defrayed by the Government of India. In October of that year the Under Secretary of State for India (Sir Louis Mallet) wrote to Chesney emphasising that "Lord Salisbury is desirous that the College should be made self-supporting, and that the receipts should cover the entire charges, inclusive of interest on the cost of the buildings and C", and requesting that Chesney submit a scheme.
for restoring equilibrium - either by reducing expenditure or by raising the students fees, or by a combination of both methods.

The total current expenditure for 1875-76 had amounted to £23,605. The number of students at the College averaged 134 for the year giving an average charge per annum of about £177. However if interest were calculated at 5 per cent per annum on the capital expenditure, this yielded a further £6,000 to be distributed over 134 students, adding about £45 to the cost of each and making a total charge per student of approximately £222 per annum. Therefore the fees only covered 68 per cent of the actual cost leaving the burden of 32 per cent, or £72 per student per annum, as a charge on Indian revenue.

When Chesney received Salisbury's letter the estimates for the following year had already been submitted and amounted to £23,431 - which led one Member of the Council of India to remark that the College was "conducted on a too profuse scale of expenditure". The £23,431 consisted of:

<table>
<thead>
<tr>
<th>TEACHING</th>
<th>£</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>President and Professors</td>
<td>7,938</td>
<td></td>
</tr>
<tr>
<td>Lecturers</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Examinations</td>
<td>442</td>
<td></td>
</tr>
<tr>
<td>Laboratory and Workshop</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Divine Service</td>
<td>250</td>
<td>9,694</td>
</tr>
<tr>
<td>SERVANTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(including Bursar and Secretary)</td>
<td>2,255</td>
<td>2,255</td>
</tr>
<tr>
<td>FOOD, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food at 3s. per day, per student</td>
<td>4,683</td>
<td></td>
</tr>
<tr>
<td>Gas</td>
<td>700</td>
<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>185</td>
<td></td>
</tr>
<tr>
<td>Contingencies</td>
<td>500</td>
<td>6,568</td>
</tr>
</tbody>
</table>
Plainly the cost of the practical course represented a significant burden on College finances; the fees paid amounted to one-fifth of the cost of College tuition and the subsistence allowance to one-quarter of the cost of feeding the entire College.

Throughout the winter months of 1876-77 Chesney deliberated anxiously over the College finances in an attempt to produce a theoretical equilibrium and by March 1877 he produced a penetrating and reasoned analysis of the College's revenue and expenditure statistics.\textsuperscript{12}

Taking a revised College estimate for the year of £23,371, the income, if the College were full would be 150 students at £150 each, £22,500, leaving a deficit of about £900 a year on current expenditure. But the College had never had its full nominal complement and indeed in that year had its highest number of students ever. In March 1877 there were 137 students at Cooper's Hill of whom 47 were in their third year, 43 in the second year and 47 in the first year. The thirteen vacancies had occurred from: 4 candidates studying elsewhere, 1 death, 2 vacancies of successful candidates at the annual examination in 1876 (not filled up), and 6 withdrawals of students from various causes during their course.
However, because of a contraction of expenditure on public works in India (see below p.212), Chesney could not estimate that the number of admissions in future years would exceed the present strength and therefore added £1,950 to the above deficit making a total of £2,821, exclusive of interest on capital expenditure, to be made good either by reducing current expenditure or by raising the fees or by a combination of the two.

He was not attracted to the idea of reducing expenditure as it consisted mainly of fixed charges for salaries and services which were not susceptible of a rateable reduction for small fluctuations in the number of students in residence. Of the service charges those for rates, taxes, water supply and insurance were relatively constant although a reduction of students would plainly have admitted of a small reduction in the cost of fuel and gas - but not in proportion to the numerical decrease, as these charges were mainly incurred for the lecture and other public rooms. Similarly, whilst the subordinate staff were maintained on a strength proportional to the number of students in residence, the number of 'superior servants' was not susceptible of variation in this way unless there was a major increase or decrease of students involving an entire reorganization of the establishment. Equally the annual charge of £700 for the laboratory and workshop could not be reduced as this covered the salaries of an engineman, draughtsman and laboratory assistant together with the cost of chemicals, fuel for the engine, workshop materials and renewals to survey instruments.

The other fixed charges were those for the Professors and staff. With regard to the numbers involved, Chesney had originally fixed the strength of the Professoriate on a scale comparable with other Government Colleges. Indeed he produced tables for Woolwich and Addiscombe which demonstrated
that at Woolwich there were nineteen Professors (besides temporary assistants) for 200 students as against 12 Professors at Cooper's Hill. Similarly, at Addiscombe there were 14 Professors for the same number of students as Cooper's Hill, although the course at Cooper's Hill was considerably more varied and advanced than that at Addiscombe. On the other hand the salaries paid to the Cooper's Hill staff was somewhat more liberal than that in force at the other Colleges, but from the outset Chesney had argued that this was necessary in order to attract men of the highest calibre to the new College.

Moreover, the clerical establishment at Cooper's Hill, (which consisted of one Bursar (£300 per annum), one assistant Bursar (£50 per annum) and one Secretary (£300 per annum)), was also incapable of reduction. Indeed Chesney noted that these men were all "very fully employed" and observed in passing that the corresponding officers at Woolwich and Sandhurst were assisted by a staff of soldier clerks. The clerical staff at Cooper's Hill were further burdened with the submission of all detailed tradesmen's accounts to the India Office, and, not surprisingly, a most elaborate system of book-keeping was evolved. In exasperation Chesney declared "if a pot of jam or a glass of beer is issued to a student, the charge and the recovery have to be shown in the monthly accounts rendered for the audit. This may be the best system, but the result is that the accounts are extraordinarily voluminous and troublesome to keep, and the Bursar is distinctly overworked".  

The only items which fluctuated rateably with the students numbers were, firstly, provisions, washing, etc., and secondly, the fees and lodging money paid to the senior students while detached on their practical course. The sum for provisions and washing was arrived at by calculating the rate applied for
similar charges at Woolwich, and Chesney considered three
shillings per day per student to be a very reasonable charge.
By contrast, the cost of the practical course represented a
very substantial burden on college funds. The students on the
practical course were absent for a term and a half, or half the
academic year and their £75 fees were distributed in (a) £40
pupillage fee to the engineer and (b) lodging allowance of five
shillings per day (in term time) or £33 (approximately) so that
during this period they contributed only notional amounts
towards the college expenses - which therefore had to be met
entirely from the fees of the two junior years. Plainly the
College could never arrive at equilibrium if it was only two-
thirds full for half of each year since the establishment
generally had to be organized with reference to the greater
demands made on it for the other half of the year. From the
total cost of the practical course (£3,522) Chesney deducted the
cost of boarding the students (if they were living in College)
and calculated the net cost of the practical experience as being
£2,500 or within £500 of the deficit that required to be offset.

In consequence, he proposed a complete reform of the
College course by extending the academic course to three complete
years, so that the students would always be in residence and
contributing to the College revenue; and, at the end of that
time, the students were to be enrolled on the staff of the Public
Works Department and required to undergo a further practical
course of one year's duration (on a reduced salary of £140 per
annum) in England.

Finally, in analysing the expenditure statistics, and
particularly the salaries paid to the academic staff, Chesney
could not fail to observe that his own salary (which had been
increased to £1,500 in 1873) amounted to one-fifth of the
Professorial salaries. At first the burden of organization and administration had been very heavy but as the College developed he found his work-load considerably reduced. He now found time for a regular study of German, Mechanics, Calculus and Analytical Geometry together with writing, riding and hunting. His teaching commitment in Accounts was small and he therefore concluded: "the salary of the President forms a heavy item in the estimate, and its removal would be a sensible step towards the desired equilibrium". He went on to suggest that the business of the College could be conducted by either placing one of the Professors at the Head of it, or, by a Board of Professors in joint charge, with a fixed Chairman or one changing in rotation.

In turning to the other possible method of achieving equilibrium, he observed that College fees could only be increased to a certain point beyond which diminishing returns would undoubtedly set in. Moreover, although many students looked upon College fees as an investment yielding a return in the form of a fixed and definite income, many parents were clearly concerned about the existing scale of charges. Indeed in comparison to Woolwich the R.I.E.C. was very heavily weighted as fees at the R.M.A. varied between £125 per year for the son of a private gentleman to £40 per year for the son of a Captain in the Army, or £20 for the son of a deceased officer (and the course only lasted for two to two and a half years). Chesney also noticed that Sandhurst had recently introduced the same rate of fees but when they had previously abolished fees, there was an immediate falling off in competition for Woolwich.

Nevertheless in considering the competition for entrance to Cooper's Hill, Chesney argued that the fees could be increased marginally without significantly altering the competition.
Taking the deficit at approximately £3,000 for an average strength of 135 students equilibrium would be achieved by increasing the fees by £22 per year (per student). Instead of this he proposed to increase the fees further than to merely cover the deficit and to apply the excess in creating scholarships. "The institution of scholarships on a considerable scale at Cooper's Hill, if paid for in this way by the fees, would indeed be very advantageous". Hence he proposed that the fees be increased, not to £172 but to £180 which would yield a total of approximately £1,100 in the form of scholarships. However, this proposal would not only increase the social exclusiveness of the College but would simultaneously increase the possibility that a greater number of successful candidates would elect to be educated elsewhere.

Chesney's three major proposals did not take account of any return on capital expenditure and in desperation he wrote "if this condition be imposed, I am quite unable to propose any plan for satisfying it". He fully admitted the importance of the principle that the R.I.E.C. should as far as possible, be self-supporting, but only as an abstract proposition. Instead he urged the Secretary of State that the capital expenditure should be "thrown in as a free gift" and equilibrium maintained between current expenditure and revenue. This argument was rooted in the conviction that Cooper's Hill should be considered in relation to the entire P.W.D. budget and that by giving members of that Department a thorough and systematic engineering education it was effecting a very real economy. "If one could demonstrate that the substitution of Cooper's Hill for the old mode of recruiting the service was actually producing this fruit, then there would be an end to the argument. No person could object to an outlay of £3,000
a year, or any other sum, which was bringing in a still greater return". This proposition was plainly inaccessible to proof and in a final plea Chesney declared, "if the movement of the day towards scientific education is not based on a delusion, and if the efforts made in this direction by continental nations are not labour and money wasted, then the establishment of Cooper's Hill on its present footing must have been a step in the right direction".21
Recruitment to the I.P.W.D.

Chesney's proposals for achieving financial equilibrium at the College (in March 1877) had scarcely been received by the India Office when a scheme for the reorganization of the I.P.W.D. arrived. The proposed reorganization was submitted by Sir Andrew Clarke who had been appointed Public Works Member of the Government of India in 1874 and who found the method of voting public works expenditure in India extremely disorganised. He declared "I am hopelessly hampered by the uncertainty of the amount of future annual grants for public works. Unless I know how much I have to spend, I cannot possibly say how many men I shall require to spend it". Nevertheless in estimating the future public works expenditure at some £7.7 millions per annum he forecast a substantial excess supply of engineers to the I.P.W.D. as the following table indicates.

<table>
<thead>
<tr>
<th>Years</th>
<th>Strength</th>
<th>Requirements</th>
<th>Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>1877-78</td>
<td>1263</td>
<td>1124</td>
<td>139</td>
</tr>
<tr>
<td>1878-79</td>
<td>1275</td>
<td>1155</td>
<td>120</td>
</tr>
<tr>
<td>1879-80</td>
<td>1286</td>
<td>1186</td>
<td>100</td>
</tr>
<tr>
<td>1880-81</td>
<td>1297</td>
<td>1218</td>
<td>79</td>
</tr>
</tbody>
</table>

The annual supply in 1877 consisted of: 18 Royal Engineers, 45 from Cooper's Hill and 12 from the Indian Colleges so that if any reduction were necessary it clearly effected Cooper's Hill. Moreover Clarke's attitude to the College was characterised by hostility as he had "never approved of the institution of a special civil engineering College in England for the supply of engineers to the Public Works Department".

The immediate effect of his anticipation of a redundant staff of engineers, and his call for a reduction in recruitment
to the I.P.W.D., was that the third year students then about to embark for India were given the option of postponing their embarkation for a further year's practical course in England, on a reduced salary. Although several of the students desired to proceed direct to India the possibility of remaining in England for a further year on a salary of £140 per annum proved attractive, and many of the students elected to expand their practical experience. However, the following year saw the outbreak of the Second Kabul War in India (1878) and the recurrence of disastrous famines which necessitated the diversion of public works resources so that once again calls for a reduction of intake to the I.P.W.D. were made.

In consequence the practical course was altered from two terms in the third year (with the intervening vacation) to a complete year's course (in the 'fourth year'). This change was clearly consistent with Chesney's memorandum on the financial burden imposed on the College by the practical course, but it also attempted to remove the defects of the previous system. Previously the employers were responsible for the students and "some looked after them, others left the students pretty much to themselves, and others seem actually to have tried to prevent the students picking up knowledge or 'trade secrets'."25 Thus for example at C.F. Bergers Iron Foundry in Manchester, students were not allowed to sketch what they saw and the President wrote to the owner urging reform: "I need hardly say that they would not be likely to carry off anything which would be of value in a commercial sense".26 Another engineer boasted to "The Builder" that "the first thing I do when a student of Cooper's Hill is sent to me, is to make him forget all that he has learnt at the College".27 Not surprisingly such comments were entirely contrary to the spirit and
the letter of the instructions issued to students when leaving for their practical course which urged the use of theoretical knowledge to the fullest possible extent. Hence the new arrangement provided for a 'supervisor' to be appointed (normally an officer on furlough in England from the I.P.W.D.) to visit the students in the course of their practical experience and to report on the progress of each student.

The change in the duration of the practical course therefore had the twin advantages of removing the large deficit imposed on the College accounts whilst at the same time extending the students practical experience. The students were enlisted directly into the I.P.W.O. for the new 'fourth year' on a salary of £140 - a sum which could be augmented by 'half yearly prizes' of up to £40 per prize, payable to each student for reports written on the practical work together with the clarity of the viva voce exposition on the subjects.

An interesting perspective on the new 'fourth year' was submitted to the College Magazine, the Oracle.

"THE YOUNG ENGINEER" 28

"The Young Engineer, when he's finished his training, And nothing of theory to study remaining, Should obtain a more thorough Professional Knowledge, Than he has been able to gain, when at College. He should seek for a town, very dirty and drear; (for society's bad for the young engineer). Dry bread and cold meat, (indigestible veal) Will greatly encourage "Professional Zeal". He will give up amusements, tobacco and beer, And live on a hundred and forty a year. He should go when the trade is in utter stagnation, And commence a most "practical, sound, education". Nine months he will find is much more than enough To thoroughly master his practical stuff. For though poor mechanics can't learn it in years It all comes quite easy to young engineers. Thus the young engineer will have plenty of leisure, (which he mustn't once dream of devoting to pleasure) And leave he may have, when his chief deems it right From Saturday noon until Sunday at night. "The young engineer would do well if he could, "To visit some works in his own neighbourhood;" And this is an excellent way, we believe, "To employ his leisure" and most of his leave.
But, he must take most particular care
To go with no other young gay engineer;
For if he should go with his friend or his brother,
One young engineer might get helping the other!
When acquainted with these he must write a report,
To show what he's learnt, or what he's been taught;
For if one can't show to the head of his College,
What he knows, what's the good of Professional knowledge?
Thus, preventing all mercenary thoughts from encroaching
Professional Zeal in his heart will arise
"Bearing in mind that the time is approaching"
"For the award of the Half Yearly Prize!!"

FOURTH YEAR

Simultaneous with the change in the duration of the practical course the number of candidates selected at the entrance examination in 1877 was reduced from 50 to 45 and in 1878 and 1879 the number was further reduced to 35. Indeed because of the serious reduction in recruitment to the I.P.W.D. it was decided in 1877 that recruits for the Indian Telegraph Department should be trained at Cooper's Hill and not, as previously, at the Hartley Institute in Southampton. The Telegraph course was to be of one year's duration and in the first year seven students were admitted, although the annual requirement after that year rarely exceeded three telegraph officers per annum.

On these figures the College could not possibly aspire to financial equilibrium and in 1879 the Government of India called for the abolition of Cooper's Hill.29 To avoid the necessity of closing the College the Secretary of State (Lord Cranbrook) invited the President to comment on the financial viability of the College within the context of the new diminished demand for engineers from India. In a memorandum to Cranbrook dated 30th May 1879 30 Chesney argued that the reduction in demand from India was as much due to a block at the top of the service as to any excess of admissions at the bottom. He noted that in reality there were no retirements from the I.P.W.D. as
vacancies occurred only through deaths. The two principal factors which provided a block at the top of the service were, firstly civil engineers had entered the Department only recently and comparatively late in life, being taken over from the railway companies or sent out direct from Britain, so that when they reached the superannuation age of 55 years they had not served long enough to get a pension or more than a very small one. Secondly, military officers were not liable for superannuation and in the absence of enforced retirement many refused to retire. Chesney observed that "a large number of senior engineers are now being kept on after they are notoriously past work".31

In turning from the need for suitable retirement rules in the I.P.W.D. to the need for Cooper's Hill to achieve financial equilibrium Chesney pondered the impossibility of this condition by examining alternative uses for the College. The College's theoretical capacity of 150 students in residence had never in fact been achieved, and, with only 35 students entering each year, without any corresponding proportional reduction in the staff, the deficit would merely be enlarged. The following table shows the total cost to Government of Cooper's Hill, throughout its first ten years.

TABLE XVI

<table>
<thead>
<tr>
<th>Capital Expenditure</th>
<th>Simple Interest on Cap.Exp. at 3% per annum</th>
<th>Current Expenditure</th>
<th>Current Revenue</th>
<th>Net expenditure ex. Interest</th>
<th>Gross expenditure in.Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
<td>£</td>
</tr>
<tr>
<td>53,390</td>
<td>876</td>
<td>1,406</td>
<td>9</td>
<td>1,397</td>
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TABLE XVI (Continued)

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<tr>
<th>Capital Expenditure</th>
<th>Simple Interest on Cap.Exp. at 3% per annum</th>
<th>Current Expenditure</th>
<th>Current Revenue</th>
<th>Net expenditure ex. Interest</th>
<th>Gross expenditure in.Interest</th>
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<td>3,572</td>
<td>21,217</td>
<td>17,846</td>
<td>3,371</td>
<td>6,943</td>
</tr>
</tbody>
</table>

on expenditure to end of last year plus half the outlay of the year:
The calculation also takes interest at its lowest possible level at 3% per annum.

Despite the large financial deficit in the College accounts up to 1879, Chesney once again reaffirmed his conviction, that in educating its engineers thoroughly the Government was, in fact instituting a very real economy. Indeed he stressed that "the time is close at hand when the value of a professional education for engineers, as well as a practical training, will become as clearly recognised in England as it is already in other countries". One possible way of filling the College which had been suggested to him two years earlier when the demand from India first dropped off was to admit outside students to the benefit of education at the College. Now there was little alternative and he therefore proposed that the College should admit more students than the number of guaranteed appointments available: the actual competition for entry to the I.P.W.D. would then be held at the end of the College course instead of at the beginning. This proposal had the additional merit that the "great differences in intellectual calibre manifested among the men in each batch" would ensure that a higher standard of qualification could be exacted. Hence although the College had introduced a "Fellowship of Cooper's Hill" (F.C.H.) for students who gained a 'first class' in any of the four branches of study, the standard of qualification for entry to the I.P.W.D. was practically determined by the least able student who was reasonably industrious. Indeed Chesney hoped "that a time will come when the value of a proper education, being duly appreciated by the profession, Cooper's Hill might come to be a College for engineers generally, to which a certain number of Indian appointments were offered as prizes". He further
suggested that the College could be handed over to the I.C.E. although no documentary evidence exists in the archives of either institution to indicate if this proposal was ever formally communicated to the I.C.E.

**Change of President**

Chesney's memoranda on the financial condition of Cooper's Hill (1877 and 1879) were critically discussed by the Public Works Committee of the Council of India and the bulk of their recommendations finally accepted. Hence although the reasons surrounding his return to India in the winter of 1880 are not absolutely clear, it may nevertheless be asserted with confidence that the removal of his disproportionate salary was one way of effecting an economy at the College. Other related methods included raising the College fees to £180 and throwing the College open for the general education of engineers in Britain.

Before leaving Cooper's Hill to take up an appointment as Military Secretary to the Government of India Chesney was asked to recommend a successor, and, knowing that the College was about to enter a period of profound change (when its very existence would be questioned) he looked for a highly distinguished military officer to continue the traditions he himself had fostered at the College.

On hearing that Sir Alexander Taylor, the distinguished veteran of the Indian Mutiny and a brother officer at the siege of Delhi, had recently retired from the service, Chesney wrote to inquire whether the idea of occupying the post would be acceptable to him. This letter was combined with a visit to Taylor's home, for although Taylor's reputation as a soldier was well established his age and physical health aroused concern. The events which followed Chesney's visit were recounted by
Taylor's daughter, Alicia,

"He (Chesney) saw a stalwart figure and two smaller ones speeding down the slope, each perched on the summit of one of those alarmingly tall and slender wheels which preceeded the modern cycle. Suddenly the largest of these machines shot forward, and, gathering momentum on its downward course, dashed past: a flash of spokes and a cry "Field! Field!" As no one was foolhardy enough to obey this adjuration, the rider steered for a crossway hedge, breasted it, parted company with his machine, and landed gracefully on the other side. This was Taylor, who was being initiated by his boys into the art of bicycle riding". 36

Having in this way dispensed with the question of 'physical energy' Chesney was convinced he had "the very man" for the Presidency, but Taylor declined the offer saying "I am no schoolmaster, I have no gift in that way". 37 Undaunted by this reply he arranged for Taylor (a keen boating enthusiast) to visit the College and experience its flavour, by introducing him to the staff, students, workshops and the river, and further arranged that should Taylor accept the position, he would be relieved of the duty of lecturing. The package clearly impressed Taylor for on the 3rd November 1880 he moved to occupy the President's house at Cooper's Hill, which was to become his home for the next sixteen years. 38

When General Sir Alex Taylor moved to occupy the titular role of President of the Royal Indian Engineering College, the 'fourth year' students were distributed as follows amongst firms or engineers for their practical course (commencing September 1880).

Armstrong & Co., Messrs. Sir W.G., Elswick, Newcastle (2)
Banister F.D., Esq., Chief Engineer, L.B. & S.C. Railway, London Bridge, S.E. (for Croydon, Oxted, East Grinstead Railway) (1)
Bernays, E.A., Esq., Government Dockyard, Chatham (2)
Dean, W., Esq., Locomotive Works, Glasgow (2)
Falkiner and Tarcred, Messrs., Contractors, Didcot, Newbury and Southampton Junction Railway (for Newbury) (1)
Handyside & Co., Messrs., Britannia Ironworks, Derby (2)
In September 1880 there were 257 Cooper's Hill men serving in the I.P.W.D. of whom 65 were in irrigation, 67 in railways, 18 telegraph officers (the highest number to be appointed from the College in any three year period) and 107 in the Provincial Service. The Provincial Service was commonly called the "Dry", to distinguish it from the "Wet" or "Rapid" Irrigation and Railways, and the work consisted of the management of the roads, collection and consolidation of kunkur, and petty repairs to them; repairs to bridges and culverts, looking after the avenues and arboricultural operations in connection with them; erecting necessary buildings for the Government and keeping others in repair, preparing projects, designs and estimates and generally looking after the engineering requirements of the country apart from Irrigation, Railways and Military Works. The service was sometimes looked down upon in India because little revenue was derived from such works whereas much was expended upon them, but from an engineering point of view they were considered "quite as good" as Irrigation and Railways. However the service proved most attractive because engineers were not transferred as often as those in the other branches, and
with an increasing tendency for Cooper's Hill men to marry before emigrating, the "dry" service gave them the best opportunity to enjoy their home lives.\textsuperscript{39}

Although the new President of Cooper's Hill had some first hand experience of engineering in India he was primarily a soldier and had little knowledge of the latest developments in engineering education in Britain. However as it was intended to throw the College open as a school of civil engineering generally, the Constitution of the College was altered by the appointment of a Board of Visitors, "to provide a highly qualified authority to supervise, in communication with the President of the College, the course of study to be pursued, and to advise as to the internal management of the College".\textsuperscript{40} The Board was to consist of a Chairman, four civil engineers and four gentlemen specially connected with India so that the Indian and British requirements would be adequately catered for. The first Board of Visitors consisted of: \textsuperscript{41}

Chairman : Temple, Sir Richard, Bart. G.C.S.I., C.I.E., D.C.L.
Members : Barlow, W.H., Esq., F.R.S. President of the I.C.E.
Bramwell, F.J., Esq., F.R.S.
Dickens, Lieutenant-General C.H., S.S.I., R.A.
Ellis, Sir Barrow H., K.C.S.I.
Fowler, J., Esq., Past President of the I.C.E.
Siemens, C.W., Esq., D.C.L., F.R.S.
Strachey, Lieutenant-General R., C.S.I., R.E., F.R.S.
Yule, Colonel H., C.B., R.E.

Initially the Board offered substantial assistance with the remodelling of studies necessary to widen the scope of the College (particularly the distinguished engineer C.W.Siemens), but in the next fifteen years they submitted only four reports to the Secretary of State (1882, 1886, 1892 and 1895) and confined their activities largely to a formal annual visit to
Cooper's Hill. Issues connected with the internal management of the College were left to the President and the College Board.

Within the College itself many of the academic staff had well established reputations in their respective spheres when the new President arrived. Indeed some had won international recognition, and their diverse personalities offered vitality to the changing institution.

To the most senior Professor Calcott Reilly, the education at Cooper's Hill was "spoon-feeding" when compared to his own background, but he threw himself completely into the cause of systematic scientific engineering education. Many Cooper's Hill men later remembered Reilly's kindness; "on a knotty problem arising, especially during the time for designs, the student was told to call at the Professor's house and there the Gordian cord was cut or the Moments of Inertia unravelled under the warming influence of a decanter of sherry and a box of cigars". 42 His courtesy impelled him to say 'good morning' to each of his students as they filed into his lecture room, and, rather than interrupt his lecture he wrote 'G.M.' (good morning) on the blackboard for any late-comers.

Reilly's 'junior', Unwin, was promoted to equal terms in January 1875 (salary increased to £600 per annum) and throughout his twelve year residence at Cooper's Hill, Unwin was to make a prolific contribution to original research. His contribution to the development of engineering education is remarkable in that in the early 1870's almost everything had to be created in the way of systematic theoretical instruction. Thus "whereas in Mathematics there are abundant textbooks and recorded results ... in hydraulic engineering there is nothing in the English language fit to be employed as a textbook" wrote Chesney
in 1874. Unwin did much to rectify this. In 1872 he finished a work for Fairbarn "On the Durability and Preservation of Iron Ships and on Riveted Joints" which was presented to the Royal Society in April 1873. In 1874 Messrs. E. & F. Spon published their "Dictionary of Engineering", an encyclopaedic work designed to cover the whole range of the subject to which Unwin contributed articles, it is believed, on bridges and roofs. In 1876 he read his first paper before the I.C.E. on "The Resistance of Boiler Flues to Collapse" for which he was awarded the Telford Medal. In 1877 he became a Fellow of the Royal Society of Arts and also published the first edition of his book "The Elements of Machine Design", which made his name known throughout the engineering world. The book was translated into French and German and in the next eleven years was published fifteen times with a total issue of almost 22,000 copies. In 1878 he became a full member of the I.C.E. and later in the same year was elected a member of the I.M.E. In 1881 he contributed an original article on hydraulics to the Encyclopaedia Britannica which was unique in "that an article in an encyclopaedia should become a principal authority and textbook" which was later used in settling disputes relating to water flow and other hydraulic matters.

Unwin was held in high esteem at Cooper's Hill and his appearance as a lecturer - a tall dark man with gold spectacles - evoked attention. "If there was any want of attention, he would stop abruptly, fix the delinquent and not resume his lecture until he was satisfied". His personality was considered "kind, shy, fastidious, inaccessible, and yet an admirable friend, the fineness of his fibre imposed itself on all, no one showed him any but their best self". However when the Presidency changed at Cooper's Hill, Unwin was destined
to have but three complete years left at the College, for in
1884 he accepted the post of Professor of Civil and Mechanical
Engineering at the Central Institution of the City and Guilds
of London Institute becoming at the same time Dean of the
College. 47

By comparison with Unwin the other principal academic
staff produced (in terms of volume) but a modicum of original
research. In 1874 Professor Greenhill had resigned to accept
preferable employment at Cambridge and was succeeded by
E.J. Nanson from Trinity College Cambridge. Professor Nanson
however did "not seem to identify himself at all with the
interests of the place, and there was a great slackness in
matters when conformity with the spirit of the place was
essential to a healthy state of things, e.g. he was habitually
absent from Chapel although requiring his pupils to attend". 48
After a year Nanson was asked "to put his retirement on any
grounds he pleases", 49 and was succeeded in the Applied Mathe-
matics Chair by George Minchin Minchin from Trinity College
Dublin. Minchin had a good reputation as a mathematician and
shortly after his arrival at Cooper's Hill he produced an
original work on theoretical mechanics. He was considered
unorthodox and "admitted no allegiance to any laws save those
promulgated by his own fine intelligence and his own generous
heart", 50 and his lectures were later admired as "masterpieces
of lucidity". In contrast Professor McLeod had achieved
distinction as a chemist, was a Fellow of the Royal Society,
"a High Churchman and a Tory, and, in all paths of life, a
follower of the most orthodox of the strictest sects of ortho-
doxy". 51

Of the military staff Colonel Courtney was considered "a
man of society and a courtier by instinct" who presided over
all College festivities such as balls and sports. Lieutenant Clarke left Cooper's Hill in the same year as Taylor joined; he, to pursue a distinguished politico-military career which eventually gained him the Governorship of Victoria and later of Bombay together with a Peerage.52

Taylor clearly inherited an academically vigorous institution but one that was uniquely burdened with the need for financial equilibrium. Despite his appointment as the apparently 'titular' head of the College he immediately focussed attention on the possible techniques of making the College self-supporting. Between 1880 and 1883 the "new scheme" was introduced (with the assistance of the Board of Visitors) whereby the assignment of Indian appointments amongst the students was deferred until after the final examination but the number of such appointments was not expected to exceed 20 engineers per annum. With this reduced number of appointments the only inducement the College could extend to potential applicants was the somewhat remote prospect to "endeavour to place students who had duly qualified for the College Certificate, but who did not enter the Indian Service as pupils for one or two years with civil or mechanical engineers of standing, at moderate rates of premium".53

In preparation for the "new scheme" at Cooper's Hill substantial capital was spent in expanding the Mechanical, Chemical and Physical Laboratory facilities in a bid to attract students. Nevertheless until the "new scheme" was tested it was impossible to state that the increase in fees would have the desired effect (in achieving financial equilibrium) because it was not known if enough students would be forthcoming at the increased rate.

The "new scheme" also necessitated staffing alterations
Seated: Prof. Stocker, Prof. Wolstenholme, Sir Alex Taylor, Prof. Reilly, Col. Edgecombe.

Back: Prof. Unwin. Mr. Pasco R.N. Mr. Whiffin R.N. Mr. Heath.
and changes in the curriculum by, inter alia, the appointment of Herbert McLeod to the Chair of Chemistry from that of Physics (or 'Experimental Science') with W.N. Stocker being his successor in the Physics Chair. Demonstrators in these two subjects were also appointed, W.G. Gregory, B.A. for Physics and F.E. Matthews, Ph.D. for Chemistry together with an instructor in Freehand Drawing, Russel Dawson, whilst the study of Hindustani and Indian History was removed from the syllabus. In September 1883 the fees were increased from £150 to £180 per annum and the system of deferred fees was abolished and at that time the College exchanged its purely Governmental character for one of a more comprehensive scope (whilst at the same time acquiring a complete monopoly of appointments from Britain to the I.P.W.O.).

The total cost to Government of the R.I.E.C., up to the 31st March of that year was reckoned by the Accountant General to be:  

\[
\begin{align*}
\text{Total Expenditure to 31st March 1883} & \quad 355,429 \\
\text{Deduct - Capital Expenditure} & \quad 119,076 \\
\hline
\text{Deduct - Receipts} & \quad 182,788 \\
\text{Amount outstanding on account of deferred fees} & \quad 8,300 \\
\hline
\text{Add interest on Capital Expenditure, calculated at 5 per cent from the end of the year in which it was incurred, say} & \quad 63,000 \\
\hline
\text{TOTAL} & \quad 108,265
\end{align*}
\]

Plainly the College authorities were under considerable pressure to fill Cooper's Hill and, at the entrance examination in 1883, 56 candidates competed for 50 places and 49 were admitted. Indeed 19 of those admitted failed to complete the
College course and again in 1884, 60 candidates sat the entrance examination and 50 were admitted, 27 of whom dropped out before the final examination.

In these circumstances it could be argued that despite the increased College facilities, Cooper's Hill had lost its principal attraction, namely, the guarantee of an appointment on successfully completing the College course. Similarly the increase in fees to £180 (with no possibility of deferring a portion of them) had tended to increase the social exclusiveness of the College and thereby reduced a potentially large catchment area.

However, parallel to the introduction of the "new scheme" and the consequent expansion of facilities, the President was engaged in consultations with representatives of the Indian Forest Service for the establishment of a school of Forestry at Cooper's Hill. Hitherto no facilities existed in Britain for the training of foresters and the British Government was obliged to send its Forest students to the School of Forestry at Nancy. In 1880 and 1881 the Secretary of State had expressed considerable displeasure at receiving unsatisfactory reports on the English students at Nancy which it seemed were primarily due to defects in language — as a large portion of their time was spent learning French.

In the Autumn of 1881 the Inspector General of Indian Forests had visited Cooper's Hill to see if, under the altered conditions of the College, it might be possible to educate forest officers there. Sir Alex Taylor wholeheartedly supported the proposal and indeed suggested that it could train foresters not only for India but also for employment in the United Kingdom and Colonies — to which the Secretary of State agreed. However when informed of the proposal in 1882 the Government of India
replied: "We deprecate strongly the idea of setting up a forest school at Cooper's Hill at the cost of the Indian revenues at which candidates for employment elsewhere may attend as a matter of course, merely on payment of the College fees". They counter-proposed that payment should be made by Governments in proportion to the use of the College facilities, but if the Secretary of State were to proceed and establish the school, "10 candidates annually will be sufficient during the next 10 years for the requirements of the Indian Forest Department".

The decision to establish an English Forest School at Cooper's Hill was taken in June 1882 and was firmly based on the need to be independent of foreign nations for the training of English Foresters. However in view of the Government of India's reply, the proposal was held in abeyance for the next three years during which time detailed consultations were made on the viability of a forest school attached to the R.I.E.C. In 1885 the decision to establish the school was implemented and the necessary capital expenditure was sanctioned. In that year a separate building was constructed to act as the nucleus of the Forest School and when completed it consisted of classrooms, a museum and a botanical laboratory. In this block the students were to pursue their main studies - botany, forestry and entomology -, their other studies - engineering, surveying, mathematics, geometrical and freehand drawing, physics and geology - were to be pursued under the direction of the Professors and in the classrooms of the R.I.E.C. proper.

The Forest Course

The course for forest students at Cooper's Hill was of two years duration, during which time students were instructed in
Engineering (principles of road making and the building of forest bridges and other structures), Surveying (theory and practice), Geometrical Drawing and Accounts. In addition to these subjects forest students were required to attend short courses in pure and applied mathematics, physics, organic chemistry (first introduced in 1888) entomology and geology. All of these subjects were, however, subsidiary to the special forest subjects of forestry and botany which were taught by Dr. Schlich and Professor Marshall Ward respectively.

Dr. Schlich divided his subject as follows: in the first year he dealt with the various soils, climates and the regulating effects of forests on these: sylviculture, artificial and natural woods; the tending, thining, pruning, etc.; the protection of forests from man and other animals, and especially insects, and from injurious plants, climatic influences, etc. Throughout the second year the students were instructed in the utilization of forests; the technical qualities of woods, the felling, shaping and transportation of timber; the utilization of minor forest produce and the preservation of wood. Students were also instructed in working plans, and especially the arrangement of cuttings, surveying and mapping forests; measurement and determination of ages of trees and forests; and the methods of regulating the yield of forests. Dr. Schlich's course also included visits to nearby forests to add a practical dimension to his teaching.

Similarly, Professor Marshall Ward instructed the students by means of lectures together with practical work in the laboratory and in the fields and woods of the neighbourhood. In the botanical laboratory students were supplied with microscopes, re-agents and accessories and were taught the use of all appliances bearing practically on their studies. However, the
course in botany was designed to train foresters rather than technical botanists and in consequence the lectures focussed attention on the life-phenomena of the trees and plants which the students would be responsible for rearing, tending and utilizing in the future. The course commenced with instruction in the elementary biology of plants selected as illustrative types of the vegetable kingdom as well as the use of the microscope and how to apply it practically in examining the tissues of plants. Students were then instructed in the organography and anatomy of plants learning what the organs of plants are and what they do. This section of the course was made extremely practical so that roots, stems, leaves, buds, bulbs, tubers, tendrils, thorns, etc., became not mere abstractions but objects of everyday attention. The first year's course then continued with a study of cells and their contents, of epidermis and stomata, of vascular bundles and their tissues and was concluded by a study of the names and systematic position of the plants in the neighbouring fields and woods, special attention being paid to the important trees and shrubs and their relations to the forest flora of India.

The second year of the botany course focussed attention on the physiology of plants - how they feed, respire, and chemically change substances in their interior; how they grow and are affected by light, gravitation, temperature, moisture, etc.; how they are reproduced, hybridized and so on; together with the effects of various agents in the production of wood (in influencing fertility, etc.). The course was to be completed by a study of the diseases of plants, and especially of timbers and how their effects could be minimized or healed. The botany course was made extremely practical by visits to Kew Gardens for students in the second year whilst at the end of
the first year visits to Scotland, the New Forest or the Forest of Dean, were made. Again, at the end of the second year the students were to be taken to the continent for three or four months practical work in Germany or France, at the end of which time the marks for the practical course were to be added to the marks gained at College and a rank order obtained.

Simultaneous with the introduction of the forest course the expanded laboratory facilities were utilized in testing goods required in connection with contracts under execution in England for the Government of India (and for which service a testing fee was payable). Thus the chemical laboratory tested metals, portland cement, Indian rubber, paints, varnishes, etc., while the mechanical laboratory undertook tests on the breaking strain of metals, chains and so on.

By 1888 it seemed that the College had undertaken a new lease of life by expanding its facilities and diversifying its resources. At the annual Prize Day on the 25th July of that year the President made his annual report (which was then the custom) before a group of invited dignitaries from the India Office, including Field Marshal Lord Napier of Magdala (whose son was a student at the College), Mr. Godley, Sir Alfred Lyell, Sir Charles Turner, Sir C. Bernard, Sir Lepel Griffin and Sir R. Strachey. In this "very satisfactory report" Taylor drew attention to how much the College had grown in the last few years, in terms of staff, students and subjects of study. "I find that in September 1882 the number of gentlemen forming the staff of the College was 15. It is now 26 ... the number of students in September 1882 was 90. Last September it was 139 ... We teach many more subjects than we used to do. The forestry branch has recently been established, and it alone has brought with it four new subjects, namely, Botany, Organic
Chemistry, Entomology and Forestry; and we organize for the forest students an annual visit to forests in Great Britain and also a tour of three months to forests on the Continent.  

After commenting on the expansion of the College Taylor then referred to the consequent expansion in income, as he proudly declared "the years income fully covers the years outlay. So on many sides we have enlarged and I hope that I may say this expansion has been attended with advantage to all concerned."

At this juncture in the financial history of the College, it is useful to digress and consider briefly the life enjoyed by the students at Cooper's Hill.
Life at Cooper's Hill

Although a 'civil engineering College', Cooper's Hill acquired a distinct military flavour, partly from its designation as a 'Royal' College and partly from the appointment of military officers to the Presidency. Absolute punctuality and the strictest discipline were inculcated on the grounds that the absence of these qualities was not merely prejudicial to the well being of the College but also fatal to success in later life. These qualities were reflected in the routine of the College which varied from physical drill at 7.00 a.m. each morning (for 20 minutes) to the two hours of obligatory study each evening from 9.00 p.m. to 11.00 p.m. (the rules requiring that perfect quiet should be maintained throughout the buildings during these hours). Attendance at Church was obligatory although nonconformist students could obtain leave to attend other places of worship. When recruiting members of staff Chesney had observed that "if a tutor were a nonconformist or had religious scruples about attendance, of course attendance would not be expected although I doubt if a man under such circumstances would be a suitable person to become a member of our staff". From 1880 onwards the rules regarding Church attendance were considerably relaxed for students and membership of the established Church no longer regarded as indispensible for members of staff.

Breaches of discipline by students resulted in fines, rustication or expulsion, depending on the gravity of the offence. A fine of one shilling was payable for infractions of the College rules such as smoking in the public rooms or corridors on the ground floor of the College, or not wearing academical dress at lectures or at dinner. Displays of "boyish ill manners" such as insulting or insubordinate
behaviour towards any of the Professors resulted in rustica-
tion. Chesney explained his interpretation of "gross 
insubordination" to the parents of a rusticated student: 
"Your son not only disobeyed the order of a College Professor 
to leave the dining hall when making an unseemly disturbance 
there, but when called upon to account for his conduct he 
endeavoured to justify it, and so far as I understood him, he 
is apparently prepared to act in a similar way in future. 
Such conduct is of course quite incompatible with residence 
here, and I had therefore no alternative but to require him to 
leave the College". The student later apologised and was 
readmitted and indeed after 1880 fines and admonitions were 
substituted for similar behaviour. However, the altered 
sanctions were not as effective for in 1901 students were 
reprimanded for 61 incidents of bread throwing.

For the most serious breaches of discipline such as 
drunkenness the ultimate sanction of expulsion was invoked, 
but for a 'first offender' a fine and confinement to rooms 
were usually levied. Cases of drunkenness at the College were 
extremely rare but in 1885 two students were expelled for this 
reason although the first, when confined to his room, simply 
absented himself and never returned. The second had 'previous 
convictions' and his case illustrates the procedure followed by 
the College authorities. In September 1884 he was found in a 
state of partial intoxication and was seriously spoken to and 
warned: in November he was found drunk and noisy in one of the 
dormitory corridors at a time when he was under confinement to 
his room. For this offence he was rusticated for the remainder 
of the Autumn term. In February 1885 he was absent from the 
College without leave on a Saturday evening and "about 11.00 p.m. 
was seen drunk and engaged in a brawl on the road near Egham".
The following Monday he was brought before the College Board and had nothing to say in extenuation of his conduct. In consequence Taylor dismissed him from the College "a sentence which was supported by unanimous opinion of all the members of the Board who were present".74

The academic year at Cooper's Hill was interspersed with a wide variety of sporting and social activities which ranged from rugby, cricket, lawn tennis, swimming, rowing, rifle shooting and boxing to concerts, tennis parties, afternoon dances and halls. All 'manly' sports, especially those demanding a high degree of physical exertion and team spirit were actively encouraged, for they not only prepared students for the sometimes arduous physical conditions they would find in India, but more importantly they fostered the qualities of discipline, self-reliance and comradeship so essential in any "esprit de corps".

Rugby football was essentially the College game, and two good teams usually took the field.75 The 'first fifteen' maintained a consistently high standard with 272 wins and 68 draws out of a total of 503 matches played. Although the 'A' team were not as successful the team spirit suffered no dilution on that account. In the early years of the R.I.E.C. the rugby football members contributed towards a cup to be competed for by the Rugby teams in Calcutta, Bombay and Madras but the sport did not flourish in the Indian climate and the Inter Presidency matches were soon discontinued. The Cup was returned to England, and, as the "Calcutta Cup", it has been awarded annually to the winner of the England-Scotland International, which celebrated its centenary last year (1979). The R.I.E.C. produced fourteen international players (9 England, 2 Ireland, 3 Scotland) and indeed the 1877-78 season saw five
Front: T. Wynne, G. Shaw, C. Perrin.
Middle: W. De Morgan, A. Carew, S. Finney, E. Perry, A. Garrett, A. Goodfellow, T. Davidson.
Internationals in the side. In that year the distinctive football outfit (orange and purple stripes) was changed to white jerseys with monogram badge worn with blue knickerbockers and stockings striped purple and orange.

It is not possible to elaborate on each of the sports and social activities at the College in detail but the following are some of the more notable events.

The College established a good rowing reputation but unfortunately the claims of work prevented an annual appearance at Henley for the Thames Cup. At other regattas, notably Staines, Kingston and Molesey, the Cooper's Hill eights, fours and skulls enjoyed considerable success. Similarly the college rifle club (based upon the Cooper's Hill Volunteer Corps) arranged annual competitions but the claims of work prevented the 'crack-shots' of the College attending the Bisley meeting. However the rifle club acquitted itself creditably in other such matches as could be arranged.

The sports calendar at Cooper's Hill was punctuated with a wide variety of competitions, but, with the exception of the Rugby 'first fifteen', the other teams were usually of a very uncertain quality, although the Association Football, cricket and lawn tennis teams sometimes excelled. However it is noteworthy that the annual billiards competition between staff and students generally resulted in a victory for the latter with the professors possibly attesting the wisdom of Spencer's maxim that "to play billiards well was the sign of an ill-spent youth". Indeed a leading article in "The Oracle" of December 1879 rebuked "loafers" of the first year for not taking part in or attending matches of outdoor sports because they spent too much time in the billiard room.

A highlight of the sports year was the annual sports
Do I,

Bal Masqué (1893)
always of the students own creation as occasionally resort
was made to theatrical costumiers. Music on these occasions
was frequently provided by visiting orchestras, such as that
from Sandhurst, and staff, students and guests invariably
enjoyed themselves.

The sport and social activities were financed by a
Recreation Fund supported by 'voluntary' subscriptions from
staff and students together with the profits from the Buttery
and the sale of wines. The fund was administered by a
Committee who allocated grants to the various clubs and
societies usually in proportion to membership.
CHAPTER 5

Footnotes.


2. 1OR/L/PWD/8/37, p.462. On the subject of religion see also 1OR/L/PWD/8/7, p.393 and pp.361 and 369. In a letter to the Rev. A.G. Butler, dated 18th November 1873, Chesney notes "these young men are at the impressionable age, clever but tractable, and each will become when in India a representative of the country for good or evil, which it is to be must depend in great measure on the effect of their College life". 1OR/L/PWD/8/38, pp.61-64.

3. Letter from Chesney to Sir F. Halliday dated 2nd January 1872 in 1OR/L/PWD/8/37, pp.437-439. See also 1OR/L/PWD/8/8, pp.637-638, "Proposed Gymnasium and Boat House for Cooper's Hill".

4. Ibid. Chesney to Halliday in 1OR/L/PWD/8/37, p.438.

5. Ibid. See also letter from Chesney to Unwin dated 21st June 1872 in 1OR/L/PWD/8/37, pp.342-344, in which Chesney notes "If this College were to prove unsuccessful it would be I believe not from the intellectual side or the scientific, but from the social and moral that the danger would arise". He stressed that the teachers "should identify themselves with the social life of the place ...".

6. Extracted from the "Report to the Under Secretary of State for India by the Committee of Enquiry into the expenditure of the R.I.E.C." dated 27th June 1895. See "Correspondence relating to the Remodelling of the studies and the retirement of certain of the Professors and Lecturers", Cd.490 of 1901, pp.6-18.

7. Public Works Letter No.43 from the Government of India to the Duke of Argyll dated 'Fort William, 28th March 1870' - included in the "Copy of all Correspondence which has taken place up to the present time between the Secretary of State for India in Council and the Governor General of India in Council in reference to the Establishment of an Engineering College at Cooper's Hill". Parliamentary Paper No.115 of 1871, pp.18-22.

8. Louis Mallet to Chesney dated 11th October 1876 in 1OR/L/PWD/8/7, p.516 (my emphasis).

9. For annual tables of income and expenditure see the "Reports and Correspondence relating to the Expediency of Maintaining the R.I.E.C.". Cd.2055 of 1904, Appendix VI, p.42.

10. Notes by General R. Strachey dated 30th June 1876, 1OR/L/PWD/8/7, p.517. On the other hand Colonel H. Yule considered that "there is no reason why the institution should be absolutely self-supporting ...". Note by Colonel Yule dated 7th May 1877, ibid p.527.
11. Ibid. 1OR/L/PUD/B/7, p.517.

12. Public Works Letter No.168 dated 'R.I.E.C., 16th March 1877' in 1OR/L/PUD/B/7, pp.518-521. See also Chesney's Memorandum entitled "The European Civil Services in Relation to the Finances of India" dated 'Cooper's Hill, 12th October 1877' in 1OR/C/140, pp.4-6.


16. Ibid, p.519. Chesney argued his case for an increase in pay by comparing his salary to the Governor's of Sandhurst, Woolwich, Haileybury and Addiscombe. See the correspondence with General Baker in December 1872 in 1OR/L/PUD/B/7, pp.336-339.

17. Ibid. P.W. Letter No.168 (op.cit. footnote 12) p.519. For examples of Cheney's efforts to provide attractive scholarships see "Cooper's Hill Board Meetings", 1OR/L/PUD/B/14 (especially meeting on 25th January 1872) and his correspondence with Hugh Leonard of the I.P.W.D. (1OR/L/PUD/B/37, pp.304-305).


22. Minute by Sir Andrew Clarke entitled "Indian Public Works Department - Reorganization", p.4. Although Clarke's Minute is without date, the Council of India were in possession of a copy in October 1877 and the British Museum's copy has a pencilled date of '1878' (B.M. 8022 g.25). Extracts were also published in the 'Indian Daily News' in 1878.

23. Ibid, p.5.


25. 1OR/L/PUD/B/7.


28. "The Oracle", Volume V, No.44, February 1879, p.536. "The Oracle" was first published in 1874 (see 1OR/L/PUD/B/3R, pp.154-157) and lasted till 1880, but only copies from 1877-1880 remain in the Cooper's Hill Society Papers. A later
28. (continued)

magazine "The Cooper's Hill Magazine" was first published in 1897 and for the remainder of the College's existence the set is complete. (Cooper's Hill Society Papers.)

29. On the 3rd June 1879 the Government of India addressed the Secretary of State by Telegram urging the closure of the College. This Telegram was followed by a letter (P.W.No.73) on the 25th July 1879, which emphasised that with a fluctuating expenditure on public works it was impossible to employ the large numbers of men regularly being sent out. See Enclosure No.6 - Cd.2055 of 1904 "Reports and Correspondence relating to the expediency of maintaining the R.I.E.C. and other matters", pp.62-68.

30. "Cooper's Hill and the Supply of Engineers for India" Memorandum by George Chesney dated 'Cooper's Hill, 30th May 1879" in IOR/C/142, pp.395-399.


32. Extracted from Appendix VI to Cd.2055 of 1904 (op.cit. footnote 29), "Financial Results", p.42.

33. IOR/C/142 (op.cit. footnote 30), p.396.

34. Ibid, p.397.

35. Ibid, p.398. To this end he suggested that "it would be very desirable to invite some of the leading civil engineers to join a Board of Visitors ..." See Chesney to Cranbrook dated 'Cooper's Hill, 21st October 1879' in IOR/L/PWD/8/38, p.473.


38. For details of transfer of power from Chesney to Taylor see IOR/L/PWD/6/15, No.1503, 1505 and 1516. For Chesney's next appointment as Military Secretary to the Government of India see "Telegrams To and From India", IOR/MSS/EUR D/604/2 No.8 and No.80.


41. Their first meeting was held in October 1880 and their first reform of the curriculum was to remove Hindustani and Indian History from the syllabus, as being of value only for student destined for India. See the "Board of Visitors Report" addressed to the Marquis of Hartington dated 'Cooper's Hill May 1882' in IOR/L/PWD/8/47, File 7.
42. "Indian Engineering", 16th October 1892. 'Colonel Pennyquick and the Chair of Engineering at Cooper's Hill', p.249.

43. IOR/L/PWD/8/7. (Letter dated 7th December 1874 re: addition to the staff of the College), p.491.


47. See Walker (op.cit. footnote 44) for detail of Unwin's later career.

48. Letter from Chesney to Professor Donkin dated 26th December 1874 in IOR/L/PWD/8/38, p.222.

49. Ibid, p.224.


51. Ibid, p.257.

52. See "My Working Life" by Colonel Lord Sydenham of Coombe. (London, John Murray 1927.)

53. College Prospectus for 1880, IOR/L/PWD/8/9. See also the Board of Visitors Report of 26th May 1882 (op.cit. footnote 41).

54. IOR/L/PWD/8/38, p.490. Also IOR/L/PWD/8/49, File 9 and IOR/L/PWD/8/45, File 5. (W.N.Stocker, M.A., was a Fellow of Brazenose College, Oxford.)

55. See IOR/L/PWD/8/70, File 30, and IOR/L/PWD/8/355.

56. Ibid.

57. "Cooper's Hill College. Return of the working of the New Scheme". See Parliamentary Paper 192 of 1883, Order by the House of Commons to be printed 7th June 1883, p.3.

58. IOR/L/PWD/8/42, File 2. "Preliminary Correspondence before admission of Forest Students".

59. Ibid. See especially letter from Colonel George F. Pearson to the Governor General of India in Council - Revenue (Forests) No.43, dated 28th April 1881.

60. Ibid. Letter from the Government of India to the Secretary of State for India dated 'Simla, 9th September 1882'.

61. Ibid. (Letter of 9th September 1882.)
62. The "Indian Forester" (a monthly magazine edited by W.R. Fisher) provides useful accounts of the School of Forestry at Nancy and Cooper's Hill. See Volumes IX, X, VIII, XIV, XVII, XVIII, XIX and XXII. The building alterations at Cooper's Hill can be found in 10R/L/PWD/8/117, File 75, and 10R/L/PWD/8/101, File 59.

63. Dr. William Schlich was previously Inspector General of Forests in India, a post first created in 1864 for Sir Dietrich Brandis.

64. Marshall Ward was previously a lecturer in Vegetable Physiology and Histology at Owen's College, Manchester, and a Fellow of Christ's College, Cambridge. See Alicia Cameron Taylor (op.cit. footnote 36) page 273.

65. Extracted from "Indian Forester", Volume XIV, pp.277-281,

66. Ibid.

67. For a statement of the Receipts and Expenditure in respect of the Mechanical and Analytical Laboratories from 1885 to 1903 see Appendix VIII to "Reports and Correspondence relating to the Expediency of maintaining the R.I.E.C.". Cd.2055 of 1904, p.44. See also 10R/L/PWD/8/157, File 113 and 10R/L/PWD/8/184, File 142.


70. Ibid.

71. 10R/L/PWD/8/38. (Letter to Professor Dorkin, op.cit. footnote 48), p.222.


73. Letter from Sir Alex Taylor to the Under Secretary of State for India dated 'Cooper's Hill, 3rd March 1885' in 10R/L/PWD/8/93, File 51.

74. Ibid.

75. The Cooper's Hill Magazine later recalled that "The Physical test required of Forestry students on entering the College undoubtedly contributed to their success in sport ... as it prevented any "crock" from entering ...". Vol.6, No.8, p.113.


Despite the substantial reorganization of 1880-85 and the President's optimism expressed at the Speech Day in July 1888, the College finances continued to arouse concern at the India Office. Indeed within three months of Taylor's comments a 'Special Committee on Home Charges' had noted that the question which was mooted in 1879 had once again arisen, viz. that responsibility for maintaining the College should be removed from Government. This recommendation was based on two main facts: firstly, the annual requirements of the I.P.W.D. since 1883 (under the "New Scheme" at Cooper's Hill) had never exceeded 16 engineers per annum, a figure which did not warrant the maintenance of a special college as such a small number could easily be obtained from other sources. Secondly, the College represented a considerable burden to the revenues of India. Indeed to calculate its total cost to the Indian Exchequer the cost of the forest students sojourn in France or Germany would have to be added to the College expenditure as the men were not considered fully qualified until this stage was completed (despite their prior enlistment in the I.P.W.D. and Forest Departments).

Motivated by these factors the Secretary of State for India (Viscount Cross) wrote to Taylor in 1889 to suggest that the year's practical course in Britain should be abolished, on the grounds that there then existed in India ample opportunities for the students to acquire practical experience whilst at the same time contributing to the work of the I.P.W.D.

However as the proposal was not in the form of an edict it was not fully implemented until some nine years later when the Government of India, actuated by cost considerations, formally
called for its abolition. Thus in 1898-99 the 'fourth year' practical course was finally abolished and replaced by a system whereby a maximum of two students each year could elect to remain in Britain for a new two year practical course. Such students were required to have shown special aptitude in one or more of the following subjects (mechanical, sanitary and electrical engineering, mining and architecture) and it was explained to them that on arrival in India they would not necessarily be employed on the class of work in which they were specially trained.

The following table shows the cost of the 'fourth year' practical course in terms of the salaries and expenses paid to students from 1877 to 1899.

<table>
<thead>
<tr>
<th>Years</th>
<th>£</th>
<th>Years</th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td>1877-78</td>
<td>2,582</td>
<td>1888-89</td>
<td>4,671</td>
</tr>
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<td>1878-79</td>
<td>4,967</td>
<td>1889-90</td>
<td>4,357</td>
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<td>8,029</td>
<td>1890-91</td>
<td>4,380</td>
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<td>1880-81</td>
<td>6,975</td>
<td>1891-92</td>
<td>4,334</td>
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<tr>
<td>1881-82</td>
<td>7,758</td>
<td>1892-93</td>
<td>4,537</td>
</tr>
<tr>
<td>1882-83</td>
<td>6,605</td>
<td>1893-94</td>
<td>3,683</td>
</tr>
<tr>
<td>1883-84</td>
<td>5,766</td>
<td>1894-95</td>
<td>3,847</td>
</tr>
<tr>
<td>1884-85</td>
<td>2,812</td>
<td>1895-96</td>
<td>3,999</td>
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<tr>
<td>1885-86</td>
<td>3,745</td>
<td>1896-97</td>
<td>3,709</td>
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<tr>
<td>1886-87</td>
<td>4,478</td>
<td>1897-98</td>
<td>3,751</td>
</tr>
<tr>
<td>1887-88</td>
<td>4,583</td>
<td>1898-99</td>
<td>2,404</td>
</tr>
</tbody>
</table>

Hence if included in the College accounts for its twenty-two years existence it would add a massive liability of £101,974, or an average of £4,635 per annum.

The establishment of a Forest School at Cooper's Hill, on the other hand, had necessitated considerable additional expenditure in the form of:
(a) Capital expenditure for buildings, fixtures and fittings - including a small plantation, and
(b) Current expenditure in salaries for the extra members of staff.

These two factors were, of necessity, included in the College accounts whereas the cost of the foresters practical course on the Continent was charged to the Forest Department (in Taylor's calculations). In this way the College accounts were somewhat fragmented and a blurred picture emerged of the total cost of the Institution.

In February 1894 the Secretary of State appointed a special Departmental Committee to examine the financial condition of Cooper's Hill and to enquire into "the constitution and expenditure of the College" and "submit a report upon the best way of securing an equilibrium between the receipts and working expenses of the Institution". The Committee consisted of the Chairman of the Public Works Committee of the Council of India, Sir A. Lyall (succeeded by Sir C. Crosthwaite); two members of the Board of Visitors, Sir A. Rendel and Mr. H. Leonard, and two members from the India Office, Sir C. Bernard and Mr. R. Hardie.

After some sixteen months deliberation the Committee of Enquiry reported on the 27th June 1895 that they could not suggest any measures which would result in restoring equilibrium to the College finances in the immediate future. "After a course of years an approach to equilibrium between current receipts and expenditure may be attained. But no return on the heavy capital expended on land and buildings is to be expected."

The Committee noted that the surpluses which had occasionally been shown in the accounts of the College, such as that indicated by Taylor in 1888, were entirely due to the fact that the accounts did not include the foreign tours of the forest students which should reasonably be added to the cost of the College,
whereas they ignored the much greater cost of the fourth year practical engineering course (as the students had then formally left the College).

The Committee calculated the following deficits in the College accounts since 1885-86, the year in which the forest students were first admitted to the College.

<table>
<thead>
<tr>
<th>Years</th>
<th>£</th>
<th>Years</th>
<th>£</th>
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<td>1885-86</td>
<td>2,762</td>
<td>1890-91</td>
<td>389</td>
</tr>
<tr>
<td>1886-87</td>
<td>1,404</td>
<td>1891-92</td>
<td>20</td>
</tr>
<tr>
<td>1887-88</td>
<td>236</td>
<td>1892-93</td>
<td>27</td>
</tr>
<tr>
<td>1888-89</td>
<td>493</td>
<td>1893-94</td>
<td>3,186</td>
</tr>
<tr>
<td>1889-90</td>
<td>823</td>
<td>1894-95</td>
<td>1,715</td>
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These figures did not however take any account of the Capital cost of the College buildings, which, at three per cent would amount to approximately £4,091 per annum. On the other hand the figures did take account of the profits derived from the testing operations carried on in the Mechanical and Chemical laboratories which averaged in the same period some £603 per annum. Indeed in the last five years the profit from this source averaged about £1,170 per annum and there were indications that it would continue to rise as the technical expertise and the College's reputation for such tests was advanced, yet, the committee noted that "this income cannot be considered educational income".

Despite the Committee's hesitancy at including the profits of the testing operations in the College accounts and indeed erroneously including the cost of the forest students in such accounts for the years 1878-79 to 1884-85 (when there were no forest students at Cooper's Hill) the Committee nevertheless assigned the unfavourable financial condition of the College to
two causes. Firstly a large falling off in the number of students in residence which for the three years 1892-95 were 1892-93 (136), 1893-94 (123), 1894-95 (117). Secondly the high rate of expenditure at the College which was particularly noticeable since the inclusion of the Forest School. Indeed one of the most prominent features of the increasing expenditure was the escalating cost of the teaching establishment which, in 1873, exclusive of the President, had cost £5,300; in 1880 it was £6,387 and in 1884 £7,218. By 1894-95 the amount payable had exceeded £9,000 as the following table \(^\text{11}\) (p.248) indicates (which also shows the cost of the senior administrative staff, but which excludes other expenses such as allowances for gas and fuel, etc.

As in Chesney's report of 1877 \(^\text{12}\) the Committee observed how a very small reduction in the number of students in residence could seriously disturb the financial equilibrium of the College. Equally, in an attempt to converge the continually diverging income and expenditure accounts the Committee considered ways of raising income or reducing expenditure or both. Firstly with regard to increasing the income of the College, it was generally agreed that the inability to advertise a guarantee of employment at the end of the College course acted as a disincentive to potential candidates. Parents and students were reluctant to invest in a highly expensive engineering education at Cooper's Hill with no certainty of employment on successfully completing the College course. Consequently attention was focussed on methods of increasing the number of guaranteed appointments available, which in 1895 stood at twelve in the P.W.D., three in the Telegraph Department and six in the Forest Department. In this context the President proposed that officers of the Police Service might be trained at the
<table>
<thead>
<tr>
<th>APPOINTMENT</th>
<th>NAME</th>
<th>SALARY</th>
<th>Date of Appointment</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>General Sir Alex. Taylor</td>
<td>£1,000</td>
<td>3 Nov. 1880</td>
</tr>
<tr>
<td>Professor of Forestry</td>
<td>Dr. W. Schlich</td>
<td>700</td>
<td>1 Jan. 1889</td>
</tr>
<tr>
<td>Professor of Construction</td>
<td>Mr. Calcott Reilly</td>
<td>700</td>
<td>1 May 1871</td>
</tr>
<tr>
<td>Professor of Chemistry</td>
<td>Mr. Herbert McLeod</td>
<td>600</td>
<td>1 May 1871</td>
</tr>
<tr>
<td>Professor of Surveying</td>
<td>Major-General E.H. Courtney</td>
<td>600</td>
<td>1 Aug. 1872</td>
</tr>
<tr>
<td>Professor of Hydraulic Engineering</td>
<td>Mr. T.A. Hearson</td>
<td>600</td>
<td>30 Sept. 1884</td>
</tr>
<tr>
<td>Professor of Applied Mathematics</td>
<td>Mr. G.M. Minchin</td>
<td>600</td>
<td>27 Apr. 1875</td>
</tr>
<tr>
<td>Professor of Physics</td>
<td>Mr. W.N. Stocker</td>
<td>450</td>
<td>23 June 1883</td>
</tr>
<tr>
<td>Professor of Pure Mathematics</td>
<td>Mr. A. Lodge</td>
<td>450</td>
<td>23 Sept. 1884</td>
</tr>
<tr>
<td>Professor of Botany</td>
<td>Mr. H.M. Ward</td>
<td>450</td>
<td>9 Jan. 1886</td>
</tr>
<tr>
<td>Assistant Professor of Forestry</td>
<td>Mr. W.R. Fisher</td>
<td>500</td>
<td>1 Nov. 1890</td>
</tr>
<tr>
<td>Assistant Professor of Engineering</td>
<td>Mr. A.H. Heath</td>
<td>450</td>
<td>30 Aug. 1875</td>
</tr>
<tr>
<td>Instructor in Geometrical Drawing</td>
<td>Mr. A. Hicks</td>
<td>450</td>
<td>27 Sept. 1892</td>
</tr>
<tr>
<td>Instructor in Surveying</td>
<td>Mr. R.J. Woods</td>
<td>350</td>
<td>27 Aug. 1894</td>
</tr>
<tr>
<td>Instructor in Geometrical Drawing</td>
<td>Mr. C.B. McIlwee</td>
<td>250</td>
<td>21 Oct. 1892</td>
</tr>
<tr>
<td>Instructor in Chemistry</td>
<td>Dr. F.E. Matthews</td>
<td>250</td>
<td>25 Sept. 1883</td>
</tr>
<tr>
<td>Instructor in Physical Chemistry</td>
<td>Mr. T. Shields</td>
<td>250</td>
<td>21 Jan. 1892</td>
</tr>
<tr>
<td>Technical Instructor of Telegraph Students</td>
<td>Mr. F.W. Harbord</td>
<td>200</td>
<td>14 Mar. 1892</td>
</tr>
<tr>
<td>Instructor in Geology</td>
<td>Mr. J. Duffey</td>
<td>208</td>
<td>1 Dec. 1878</td>
</tr>
<tr>
<td>Instructor in Entomology</td>
<td>Professor H.G. Seeley</td>
<td>260*</td>
<td>1890</td>
</tr>
<tr>
<td>Instructor in Organic Chemistry</td>
<td>Mr. W.H. Blandford</td>
<td>200*</td>
<td>1889</td>
</tr>
<tr>
<td>Instructor in Forest Law</td>
<td>Mr. A.H. Church</td>
<td>64*</td>
<td>1888</td>
</tr>
<tr>
<td>Instructor in French</td>
<td>Mr. B.H. Baden-Powell</td>
<td>94*</td>
<td>1891</td>
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<tr>
<td>Instructor in German</td>
<td>Mr. J.A. Perret</td>
<td>98*</td>
<td>1889</td>
</tr>
<tr>
<td>Instructor in Accounts</td>
<td>Mr. T.H. Dittel</td>
<td>113*</td>
<td>1885</td>
</tr>
<tr>
<td>Instructor in Freehand Drawing</td>
<td>Mr. J.C. Hurst</td>
<td>79*</td>
<td>1885</td>
</tr>
<tr>
<td>Instructor Mechanical Laboratory</td>
<td>Mr. R. Dowson</td>
<td>198*</td>
<td>1883</td>
</tr>
<tr>
<td>Charge of Continental Forest Tours</td>
<td>Mr. P. Reilly</td>
<td>150 4</td>
<td>26 Sept. 1884</td>
</tr>
<tr>
<td>Sir 0. Brandis</td>
<td></td>
<td></td>
<td>Honorarium</td>
</tr>
<tr>
<td>Mr. J.P. Pasco, R.N.</td>
<td>400</td>
<td>26 July 1873</td>
<td></td>
</tr>
<tr>
<td>Lt.-Col. W.J. Boyes</td>
<td>250</td>
<td>16 Mar. 1892</td>
<td></td>
</tr>
<tr>
<td>Rev. C. Croslegh</td>
<td>175</td>
<td>22 Sept. 1876</td>
<td></td>
</tr>
<tr>
<td>Dr. H.E. Giffard</td>
<td>182</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aid by fee.

Sir 0. Brandis received £150 for each long tour on the Continent.
College but this attempt to prop-up an Engineering College by making it the door of access to other miscellaneous services, unconnected with engineering, was rejected by the Committee. More practical suggestions however, included Sir A. Rendel's proposal that traffic officers, both for the State Railways and the Guaranteed Companies could be trained at the College. This suggestion to enlist the support of quasi-government agencies had little impact, however, as the Railways Companies could not give three years notice of vacancies in their establishments whereas the requirement of State Railways was only for two Traffic Officers per annum. A further proposal was to combine the total number of appointments in the three services and advertise them collectively instead of separately. Thus "21 appointments to the public service" would be offered which it was calculated would "add 13 to the list of students in residence" although the forest students would then have to be selected at the end of a first year general engineering course. This proposal was opposed by the Forest staff who argued that it had little merit for their department.

Turning to the possibility of reducing expenditure at Cooper's Hill this question naturally divided itself into (a) the fixed cost of the teaching establishment, and (b) the somewhat fluctuating cost of provisions, washing, fuel and so on.

With regard to (b) the Committee invited the Deputy Accountant General, Mr. A.G. Scott, to visit the College and inspect the books and make general enquiries about the cost of the non-teaching establishment. Scott however was unable to suggest more than minor economies at the College which amounted in total to £600.

The suggested reductions were:
<table>
<thead>
<tr>
<th>Present Salary</th>
<th>To be reduced to</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>£ 300</td>
<td>£ 150</td>
<td>£ 150</td>
</tr>
<tr>
<td>£ 190</td>
<td>£ 100</td>
<td>£ 90</td>
</tr>
<tr>
<td><strong>(ii)</strong> Chaplain</td>
<td></td>
<td></td>
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<tr>
<td>£ 190</td>
<td>£ 100</td>
<td>£ 90</td>
</tr>
<tr>
<td><strong>(iii)</strong> Professors house repairs to be in future done by the occupants</td>
<td></td>
<td>£ 200</td>
</tr>
<tr>
<td>£ 190</td>
<td>£ 100</td>
<td>£ 90</td>
</tr>
<tr>
<td><strong>(iv)</strong> Professors fuel and light allowances to be discontinued</td>
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<td>£ 140</td>
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<tr>
<td>£ 190</td>
<td>£ 100</td>
<td>£ 90</td>
</tr>
<tr>
<td><strong>(v)</strong> General Courtney's drill allowance to cease</td>
<td></td>
<td>£ 20</td>
</tr>
<tr>
<td>£ 190</td>
<td>£ 100</td>
<td>£ 90</td>
</tr>
</tbody>
</table>

The Committee agreed with the recommendations (ii), (iv), and (v) but as the houses were owned by the College they rejected (iii) and instead of (i) they suggested that the offices of Bursar and Secretary, for which a total salary of £700 per annum was payable, should be combined on a reduced annual salary of £250 "the assistance of a good clerk being given". 15

Similarly the Committee recommended minor economies with regard to visiting lecturers which included the withdrawal of Sir D. Brandis' allowance in connection with the foreign tours of forest students and the discontinuance of Mr. Baden-Powell's lectures in Forest Law. The saving here amounted to £250 per annum and a saving of £200 was recommended in connection with the forest school's plantation.

Rounding on the main body of the teaching establishment the Committee noted that the number of teaching staff was "largely out of proportion to the number of students". Indeed even if the College succeeded in attracting 140 students the staff/student ratio would be 1 to 5½ for the whole College and 1 to 3 for the Forest students. Moreover when commenting on the disproportionate burden of the Forest School on the College
accounts the Committee declared that "it is not possible to provide for the special education of Forest officers without considerable expenditure on the part of Government, to fully cover which fees from students cannot reasonably be exacted". In consequence they proposed to charge part of the deficit (amounting to £754) then shown against the College to the Forest Department. However, in concluding the report the Committee thought it "doubtful if it be worth the while of Government to continue to maintain the College at such a heavy cost, both to the Government and to the students themselves".

Two separate notes of addenda were included: the first by Mr. H. Leonard argued that the existing proportion of staff to students (1:4) was excessive and he would "direct the President to make such a reduction of staff ... as would approximately equalize current income and expenditure". The second, by Sir Charles Bernard, noted that for a College of about 120 students a separate paid President who took no part in the educational work was unnecessary. He suggested that "a separate salaried President should not be re-appointed when the next vacancy occurs" as a senior member of staff could perform the administrative duties then falling upon the President.

**Change of President**

Bernard's obiter dictum had an almost immediate effect as Sir Alex Taylor was expected to retire in 1896 and Professor Calcott Reilly at the Easter Term in 1897. Consequently when the Secretary of State, (Lord George Hamilton), appointed Taylor's successor, Colonel John Pennycuick, the appointment was tenable from September 1896 "for ten years, on condition that he will undertake the duties of Professor of Constructive Engineering at Easter 1897, on the retirement of Mr. Reilly. The salary will be a consolidated salary of £1,000 a year with
free house and C., and there will be no claim to pension, but the appointment is tenable with any pension that the holder may have earned in the Government service". 20

Little documentary evidence exists on the selection procedure adopted when Taylor's successor was appointed 21 although the Principal of the Thomason College Roorkee, Lieutenant-Colonel Chibbon and General Sir Harry N.D. Prendergast had applied for the position. Moreover the Journal "Indian Engineering" reported that "it is understood that the late Sir James Bourne was the selected candidate to succeed Sir Alex Taylor ... Mr. O'Callaghan, lately Secretary to Government, P.W.D., and Colonel Ottley who shortly retires from the Irrigation Department, are now believed to be well in the running for the post". 22

Pennycuick on the other hand had gone through all the grades of the I.P.W.D. in the Madras Irrigation branch from Assistant Engineer to Secretary to Government and was universally acclaimed as "the Perryar Dam Engineer". Although eminently well qualified in practical engineering Pennycuick had little experience of academic teaching or administration and within two years of attempting the combined duties he represented to Lord George Hamilton "that the arrangement was one which could not be satisfactorily worked". 23 After considering the matter in Council the Secretary of State decided to relieve Pennycuick of his Professorial duties without reducing his salary "which was the same as that drawn by his predecessors, who took no part in the teaching of the College". 24

In consequence Dr. Arthur William Brightmore was appointed to the Chair of Engineering at Cooper's Hill with effect from September 1899. Brightmore had no previous experience in teaching but was formerly resident engineer on the Birmingham
Waterworks where he was in charge of 20 miles of the aqueduct (the contract for this section being for about half a million pounds). He was appointed to the Professorship at the R.I.E.C. by the Secretary of State for India but without the support of the President who expressed displeasure at the nomination.25 Plainly Pennycuick felt his position undermined by the appointment and when the Government of Queensland sought his assistance with the devastating floods which periodically visited that State he tendered his resignation which was immediately accepted. He arranged to depart for Brisbane by the end of September leaving little time to find a successor but the Secretary of State provided for the most senior Professor at the College, Professor McLeod, to assume the role of caretaker President until a new appointment was made.26

The interregnum lasted only three weeks and on the 11th October 1899 Colonel John W. Ottley, C.I.E., R.E., was appointed to the Presidency. Ottley had apparently been a candidate for the position in 1896 and had formidable practical engineering experience having risen from the ranks of Assistant Engineer to become Chief of a Province and eventually Inspector-General of Irrigation.27

Reform of the Curriculum

Before leaving Cooper's Hill Pennycuick expressed concern to the Board of Visitors that the entrance examination was too easy and that in his opinion 10 per cent of those admitted were unable to follow the course with advantage to themselves, while they obstructed the progress of their better instructed comrades. This view was considered "too sanguine" by Ottley who noticed shortly after his arrival at the College that "in both the first and second years at the present time there are many students who have not progressed as they should".28 Moreover, TABLE XX 29
<table>
<thead>
<tr>
<th>Year</th>
<th>Sat at Exam. or Exempted</th>
<th>Qualified</th>
<th>Actually entered the College</th>
<th>Dropped out of College before completion</th>
<th>Completed the Course</th>
<th>Appointed to the Indian Service (excluding Foresters)</th>
<th>Completed course but failed to obtain Indian Appointment</th>
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<tbody>
<tr>
<td>13</td>
<td>56</td>
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<td>38</td>
<td>10</td>
<td>28</td>
<td>24</td>
<td>4</td>
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</table>

Though these students did not obtain appointments as civil engineers in I.P.W.D., many nevertheless worked in that Department as periodically missions in the Royal Engineers were given to Cooper's Hill graduates. E.g., eight were given in 1886, nine in 1889, two in 1890 and so on. Se and other appointments as engineers in the Colonies throughout the 1d were initially due to General Taylor's exertions to ensure that all sed students found employment on leaving the College. Indeed as the per's Hill reputation expanded demand generally exceeded supply but guarantee of employment at the end of the College course could not be artised beforehand.
(p.254) shows that in the eighteen year period 1883-1900 (inclusive) 782 students actually entered the College but only 502 completed the course leaving 280, or approximately 30\%, as 'drop-outs' during the three year course. Plainly not all of those who 'dropped out' were unable (intellectually) to complete the course and indeed Ottley considered that at least part of the blame for the failures "must be laid at the door of our own course of instruction".\(^{30}\)

On closer examination he found numerous anomalies in the range of subjects offered at the College, the relative marks assigned to each and the total number of hours of instruction given per week. In particular he found that comparatively new disciplines such as electrical engineering were only taught as 'optional' subjects at the College whereas he felt that "the study of at any rate the elements of the subject should be made compulsory on all engineering students". Indeed in the area of canal and railway engineering he observed that "the present system is antiquated, illogical and quite out of date. What is required is a thorough overhauling of the whole system".\(^{31}\)

Unlike his predecessor, Ottley was not burdened by a heavy teaching commitment at the College and he had little scruple when he found it necessary to jettison some 'deadwood' in an effort to achieve financial buoyancy and academic efficiency. "The first thing" he noted, "is to settle what we want the men to learn, and then to decide how best to afford the necessary instruction".\(^{32}\)

Ottley considered the matter for some seven months during which time no consultation took place between himself and his academic colleagues, but on the 13th June 1900, he presented a 'Memorandum on the Educational Course at Cooper's Hill' \(^{33}\) which was to have a devastating effect on the future of the
College. It is doubtless that in writing this report Ottley was actuated by the most laudable motives, particularly his impression that "a much better education might be given at much less cost" but in implementing his proposals he displayed a notable absence of the basic qualities of tact or diplomacy. His proposals are of such importance to warrant a detailed examination, subject by subject, for they shed light on the internal evolution of the College up to the turn of the century.

After inspecting the College Calendar and deducting periods set apart for examinations, recess and so on, Ottley found the actual time available for teaching never exceeded 90 weeks of 5½ days each week. The following timetable was prepared by Dr. Matthews and shows in the final column the total number of hours (under supervision) devoted to each of the subjects in the four branches of study.
<table>
<thead>
<tr>
<th></th>
<th>AUTUMN TERM (1899-1900)</th>
<th>EASTER TERM (1899-1900)</th>
<th>SUMMER TERM (1899-1900)</th>
<th>TOTAL</th>
<th>H.P.W.</th>
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<tr>
<td></td>
<td>3 Y</td>
<td>2 Y</td>
<td>1 Y</td>
<td>3 Y</td>
<td>2 Y</td>
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<tr>
<td>Geometrical Drawing</td>
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<td>7.2</td>
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<td>-</td>
<td>-</td>
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<td>Freehand Drawing or</td>
<td>-</td>
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<td>-</td>
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<tr>
<td>French or German</td>
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<td></td>
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<td>Estimating</td>
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<td>-</td>
<td>-</td>
<td>3.4</td>
<td>-</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>2.0</td>
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<td></td>
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<tr>
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<td>3.0</td>
<td>-</td>
<td>3.9</td>
<td>2.8</td>
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<tr>
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<td>3.8</td>
<td>-</td>
<td>3.8</td>
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<td>Branch IV</td>
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<tr>
<td>Physics</td>
<td>-</td>
<td>1.2</td>
<td>1.2</td>
<td>-</td>
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<tr>
<td>Drill</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
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<td><strong>TOTALS</strong></td>
<td><strong>15.6</strong></td>
<td><strong>32.9</strong></td>
<td><strong>34.4</strong></td>
<td><strong>14.7</strong></td>
<td><strong>30.0</strong></td>
</tr>
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</table>
This period of 26.5 hours per week for 90 such weeks was considered by Ottley to be so short "that we must adhere to essentials, and rigorously discard all luxuries, however tempting they may appear to be". Moreover the total time per week compared unfavourably with Colonel Chesney's first timetable in 1871 which allowed for 42½ hours per week and in consequence Ottley proposed an increase to an average of 32.4 hours per week thus obtaining in the course of the three years no less than 549 additional hours for instruction.

In erecting a hierarchical order of subjects to be studied, "Engineering" naturally occupied the premier position in an Engineering College. Under this title Ottley placed "Surveying", "Drawing" (geometrical, mechanical and free-hand), "Estimating" and "Accounts", "Electrical Engineering" and "Operations in the workshops and Mechanical Laboratory" as well as "Engineering Construction" in all its branches.

Next to "Engineering" came "Mathematics" (pure and applied) and after this came "Chemistry", "Physics" (other than Electricity) and "Geology". These to Ottley were all the essential subjects and limitations of time precluded the study of Continental languages although he would have liked "Hindustani" taught at the College. The list compares remarkably with Chesney's original design so it is interesting to note the development of the various subjects.

It was widely known at the College that the subject "Engineering" had developed into a cumbersome structure and indeed shortly after Pennycuick was relieved of his Professional duties, Professor Hearson wrote to suggest that all subjects then taught under the heading "Engineering" should be lumped together and placed under a single Professor of Engineering (viz. himself). The subjects then taught under that heading
included Applied Mechanics (including the theory of the strength and elasticity of materials and structures), Hydraulics, Theory of Machines and Thermodynamics, Descriptive Engineering, Surveying, Bridge Design, Mechanical Design, Project Work and the Control of the Mechanical Laboratory and Workshop. However the subject was divided into three distinct areas with three different Professors; Mr. Heath took "Descriptive Engineering" (as much of the subject as could be dealt with without Mathematics), Professor Hearson took "Hydraulics" and "Mechanical Engineering" and when Dr. Brightmore was appointed he took what was left by the other two. This arrangement dated from Chesney's era when Professor Unwin was appointed to teach "Hydraulics" because Professor Reilly had not felt competent to teach that subject, whereas Mr. Heath was then appointed to teach "practical engineering as opposed to the theory of construction". However by any cost-benefit analysis the arrangement proved expensive as Mr. Heath spent 36 hours per week on the subject, Professor Hearson, 10 hours, and Dr. Brightmore 7.1 hours on a combined salary of at least £1,985 per annum.

As Dr. Brightmore was particularly well qualified in "Hydraulics" and indeed was competent to teach the whole range of the subject (excluding surveying, drawing, estimating and architecture) Ottley proposed that there would be no difficulty in finding a suitable assistant for Brightmore, on a salary of £450 a year (combined emolument £1,150) making a saving of £835 per year. 37

Surveying on the other hand had formerly cost £950 per annum and here Ottley proposed an Instructor on £450 and an assistant instructor on £350 giving a saving of £150 per annum. For "Drawing", "Estimating" and "Architecture" he proposed very minor modifications in the number of hours per week but for
"Electrical Engineering" he argued that "no man at the present day can be said to be properly equipped if he has not been taught at least the rudiments of the science, and something of its numerous applications in the profession". Hitherto this subject was regarded as an "alternative" subject with only 5 or 6 students taking it each year. Ottley proposed to make the subject compulsory and to appoint a specialist to teach it on a salary of approximately £300 per annum.

In "Accounts" he suggested a considerable change from the mercantile and banking accounts then taught to the more specific accounts of disbursers, such, for instance, as fall to the lot of sub-divisional officers in India (despite the fact that only a small number of entrants were destined for India!). For the "Workshop and Mechanical Laboratory" he also proposed a significant change. These two establishments were some 50 yards apart and regarded as separate entities, each with its own staff of workmen, engines and machinery. Indeed students paid only eight visits each to the Mechanical Laboratory for the purpose of learning to test materials. The arrangement developed because the Workshop was started under Professor Reilly whilst the Mechanical Laboratory (which was built later) was placed under Professor Unwin. Ottley proposed to build a new mechanical laboratory in extension of the workshop and to hand over the existing mechanical laboratory to the Telegraph students, whilst at the same time he proposed a substantial increase in the total number of hours spent in the new amalgamation.

Like Chesney before him Ottley stressed the importance of Mathematics to an engineer which "can hardly be over-emphasised". However the study of Mathematics at Cooper's Hill only occupied
the first two years and many students entered the College with an insufficient grounding in the subject. Consequently Ottley proposed that the entrance examination should be considerably 'stiffened up' and at the same time he suggested that an average of 7.4 hours per week should be spent on the subject, spread over the whole course, in place of the existing 6 hours per week.

In "Chemistry" he proposed a 'complete remodelling' since "we are not aiming at turning out "Chemists" but "Engineers" who only need sufficient knowledge of chemistry to enable them to interpret the results given to them by professional chemists. To go beyond this is a waste of time". He calculated the total salary bill for the subject as £1,305 per year (which included the cost of chemicals, Demonstrator, lecture assistant and laboratory boy) for a total of about 15 hours of instruction per week. Hence he argued that "all that we require could be taught by one man on much less pay, and that the whole cost need not exceed say £645, or a saving of £660 on this one subject alone".

Turning to "Physics" he questioned whether the Electrical Engineer could not teach all that was wanted or if not "an occasional lecturer might be imported" thus saving a substantial amount of the then salary bill of £1,065 per annum. Next he noted, "I have cut 'Geology' down very largely as I cannot find time for more than 30 lectures in all. This should suffice to give a general idea of the subject, and more cannot be asked for".

As noted above he proposed to abolish French and German which at that time, for engineer students, were regarded as an alternative to freehand drawing. This latter subject he wished to make compulsory as 'every engineer should be capable
of making an intelligible freehand sketch for the information of his superiors or the guidance of his subordinates. His only concession to languages was to urge that Hindustani should be taught at the College. The system of 'alternative courses' at Cooper's Hill did not end with either freehand drawing or French or German. It was extended to other aspects of the course such as the following option for third year students:

- Turbine Design and OR Turbine Design and OR Electrical
- Architectural Design OR Chemical Laboratory OR Engineering

Despite the fact that Ottley saw little merit in "turbine design" as a subject, he recommended that the entire practice of alternative courses should be abolished. He further proposed, alterations in the marking system, the relative weight attached to each subject, and in the system of 'Private Study' at the College. Parallel with the decrease in lecture hours at Cooper's Hill the system of 'private study' had been expanded until by 1900, in Ottley's estimation it formed 'objectionable proportions'. He recognised that many men worked steadily in their rooms, but many did not, and the system encouraged the "copying of note-books and the fudging of plans and plates". It also lead to "idleness during a considerable portion of the time, and then to night work towards the end of the various periods".41

In concluding his report Ottley included a detailed outline of his suggested timetable and mentioned in passing that marks might also be allocated for discipline in the College. This he proposed to substitute for the elaborate system of fines which had then evolved and by allowing a total of 800 marks for discipline he calculated that one mark should be equivalent to one shilling "so that where a man was now fined one shilling he should lose one mark".

Ottley's Memorandum was submitted to the Board of Visitors
who held a meeting on Tuesday 24th July 1900 to discuss the issues raised. Eight of the nine members of the Board attended this meeting and all were unanimous in their report which accepted the bulk of Ottley's recommendations. One notable exception however was the Board's retention of French and German which Sir J. Wolfe Barry had strongly supported from a professional point of view. The Board concluded their report by expressing their gratitude to Ottley for his Memorandum and 'under his administration, we anticipate that the Royal Indian Engineering College is about to enter on a career of increased usefulness'.

**Effects of Curriculum Reform**

(a) **Capital Expenditure**

By August the Board's Report together with Ottley's Memorandum were submitted to the India Office for final approval and action. On the 6th September sanction was given for Capital Expenditure for the new Mechanical Laboratory and Carpenters Shop and immediately Dr. Brightmore began the work of ordering the necessary fixtures and fittings to bring the Laboratory up to the most modern standards. Altogether the work involved an expenditure of some £7,000 including the cost of the building and an allowance for contingencies.

The additional apparatus purchased included:

- An elevated tank to hold 12,000 gallons at height of about 50 feet above ground, carried on braced columns with inlet, outlet, steadying chamber, valves and connections: £850
- Measuring tank underneath above with room for pumps and C. and passage to laboratory: £200
- Oil filled boiler with 5 h.p. compound engine, fuel heater, oil regulator, automatic feed, arranged to drive a centrifugal pump and direct acting pump through gearing: £180
- Centrifugal pump and direct acting pump with fittings: £150
- Spirit engine to work centrifugal pump as an alternative: £100
Mechanical Workshop (1902)
<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line of three inch cast iron pipes with bends fixed round Laboratory for experimental purposes</td>
<td>80</td>
</tr>
<tr>
<td>Mercury gauges, hook gauges, etc.</td>
<td>70</td>
</tr>
<tr>
<td>Turbines and fittings</td>
<td>120</td>
</tr>
<tr>
<td>Weirs and notches with valves for regulating flow</td>
<td>100</td>
</tr>
<tr>
<td>Venture and other water meters</td>
<td>50</td>
</tr>
<tr>
<td>Apparatus for pipes and C. testing with force pump</td>
<td>80</td>
</tr>
<tr>
<td>25 h.p. Experimental Engine with separately fired superheater</td>
<td>800</td>
</tr>
<tr>
<td>Boiler for 25 h.p. Experimental Engine (as above)</td>
<td>200</td>
</tr>
<tr>
<td>Indicators, gauge testers and C.</td>
<td>80</td>
</tr>
<tr>
<td>Fans with fittings</td>
<td>40</td>
</tr>
<tr>
<td>Air compressor</td>
<td>100</td>
</tr>
<tr>
<td>Torsional testing machine</td>
<td>150</td>
</tr>
<tr>
<td>Wohler testing machine</td>
<td>200</td>
</tr>
<tr>
<td>Apparatus for measuring bearing friction</td>
<td>60</td>
</tr>
<tr>
<td>Grinder fitted up to directly measure stresses in members</td>
<td>60</td>
</tr>
<tr>
<td>Electrical pump</td>
<td>130</td>
</tr>
<tr>
<td>Portable engine, saw bench and shed</td>
<td>600</td>
</tr>
<tr>
<td>Dynamometers, calorimeters, etc.</td>
<td>100</td>
</tr>
</tbody>
</table>

(b) Reduction of Staff

It took some three months for the rest of Ottley's Memorandum and the Board of Visitors Report upon it to be digested by the Secretary of State and the Council of India. However in a letter dated 2nd November 1900 the Under Secretary of State declared that the Council of India had formally approved of the Memorandum as modified by the Board of Visitors. In consequence "Engineering" was to be placed under a single Professor with one Assistant, a specialist electrical engineer was to be recruited to undertake the work then partially performed by the Physics staff; Chemistry was to be greatly reduced and a new system of accounts introduced. These modifications involved the retirement of the following gentlemen.
This substantial reduction in the teaching staff was to have profound implications for the future of the College, and, although it seemed that a balance had been struck between efficiency and economy inside the College, it brought the College into the outside arena of public discussion and controversy (which it had always sought to avoid).

In a letter dated 14th December 1900 the Secretary of State requested the President to inform the above gentlemen that "while regretting the necessity for reducing the staff, and fully recognising the value of their past services, is compelled to give them notice that they will be required to vacate their appointments at the end of the next Easter term". This letter stated that the decision was made "with a view to reducing the present excessive cost of the staff and increasing the efficiency of the teaching" recommended in the Board of Visitors Report, but did not mention that that Report was based upon Ottley's Memorandum on the curriculum.

In a brief covering letter Ottley made no attempt to explain to the staff the necessity for reduction and had not previously warned them of any drastic changes. The letter merely stated:
"Cooper's Hill, Englefield Green, Surrey, December 17, 1900.

Sir,

I have the honour to forward for your information a copy of a letter, P.W. 2531, dated 14th inst. from which you will see that I am instructed to convey to you the decision of the Secretary of State for India in Council that you will be required to vacate your appointment at this College at the end of the next Easter term.

I have the honour to be, Sir, your obedient servant.

John W. Ottley, President R.I.E.C.

Throughout this period the Minutes of the College Board contain no reference to any impending streamlining or reduction in staff, and it is clear from subsequent correspondence that this was a 'bolt out of the blue' for the seven affected gentlemen. Indeed in a Memorial to the Secretary of State dated 27th December they stated that "no member of the staff has been consulted respecting the changes proposed in the curriculum in the letter of November 2, 1900, to which reference is made in the communication of December 14 previously referred to. We are at present in ignorance of what those changes are and also of the recommendations which have been made by the Board of Visitors".46

The Memorial further stated that the seven gentlemen had given some of the best years of their lives to the College and had borne their full share in the success which the College had achieved. Now they were to be rewarded with an abrupt dismissal in the middle of the work of the session without any reason or explanation given. In consequence they called for an Independent Committee of Experts on scientific engineering education and College Management to be appointed to inquire into the working of the College, "and that the whole of the teaching staff may be allowed to state their experience to that Committee".
One week after submitting the Memorial (via the President) and without even an acknowledgement being received (neither from Ottley nor the India Office), they forwarded their dismissal notices together with a copy of the Memorial for publication in the "Times". This action was later to prove a political time-bomb, which, for the future of the College, was not ignited until some two years later.

Throughout the scientific world the blunt dismissal of men such as Professor McLeod caused a painful shock, partly because of the method of dismissal and partly because of the incomprehensible and preposterous notion that such men were to be dismissed to make for efficiency. Almost immediately the letter columns of the "Times" and other journals were inundated with letters of support for the Memorialists in their efforts to achieve justice by the appointment of a Committee of Enquiry. In a letter of the 5th January 1901, M.S. Pembrey of Guys Hospital Medical School declared the dismissals 'immoral' and proclaimed "it is essential for the progress of scientific education and research in this country that all scientific men should combine to prevent the arbitrary dismissal of their fellow workers in science". In commenting on the curt letter which accompanied the dismissals he noted that the President was a military officer and accustomed to exercising absolute power over his subordinates. This arrangement was not beneficial for an educational institution and he therefore called for the President to be relieved of control of the educational details "and to place it in the hands of those competent for the work" (i.e. the teaching staff); the President's salary being reduced in proportion, or alternatively to dismiss Ottley and "appoint an educational expert as President".
Clearly whatever arguments may have been used in defence of the policy of reducing the cost of the staff, the manner in which the reduction was made permitted no defence and indeed many journals likened the dismissal notices to that given to an artisan, coachman, domestic servant, civil service messenger or housemaid. The "Daily News" (16th January), "The Engineer", "Engineering" (4th, 11th January), the "Morning Post" (5th January), "The Statist" (12th January) and the "Mining Journal" (12th January) all supported in leading articles the call for a Committee of Enquiry.

Major support however, came from Lord Kelvin who wrote to the "Times" that the "sudden and arbitrary dismissal of able and distinguished scientific teachers who have been doing duty for periods of from 9 to 30 years in a satisfactory manner is certainly not to be expected in institutions under the control of the British Government; and I sincerely hope that the Secretary of State for India in Council will see his way to granting the request for an inquiry".48

In reply to the Memorialists the Secretary of State rejected the proposal on the 15th January as "no useful purpose would be served", because, "in respect of technical and scientific knowledge" the Board of Visitors "are fully qualified to deal with any question concerning the management of the College".49

Unaware of this rejection the "Times" thundered in a Leading Article that the Secretary of State would "be guilty of a grave and lamentable error if he is induced by the promptings of official pedants to refuse the demand for inquiry ... ". Indeed the "Times" compared the matter to the fall of Gladstone's Government in 1874 when one factor was Mr. Ayrton's "contemptuous reference to his intellectual superiors, Sir Joseph
Hooker and the staff at Kew, as "gardeners". They further noted that the training of a scientific teacher represents the work of a lifetime and officials "of the clerk like type" were apt to think that a Professor "if he loses one place, can easily find another, like a skilled artisan or a well-trained domestic servant". The whole matter was "incredible" that an engineering College "should be governed by an engineer officer, without any special qualifications in education or scientific knowledge, and that it should be ruled by him, substantially as an autocrat, without any attempt to consult the staff in educational matters".

In fact the early "Regulations" drawn up by Colonel Chesney had provided that the President "shall be assisted in the arrangement of the studies by a College Board, composed of the Professors of the principal branches of study, with whom he shall from time to time confer on the matters relating to their branches. He should also from time to time during each term call together the whole body of the Instructors, and take their opinion on matters connected with the general interests of the College". This regulation however was more honoured in the breach than in the observance, and, when called upon by the Secretary of State to justify the lack of consultation, Ottley attempted to exculpate himself by reference to the precedent established by the College Board.

There were three different classes of meetings, viz. "annual", "emergent" and "ordinary" meetings. The annual meetings were held in connection with the final examinations in July of each year to consider the reports of the various "marks" committees and to make recommendations (before Speech Day) as to academic distinctions, prize-winners and disqualifications, etc. Emergent meetings were those suddenly called by the President to
consider urgent matters, generally in connection with College discipline, such as cases of drunkenness or the use of foul language. Occasionally they were called for other purposes and indeed Ottley called one in January 1901 in connection with a proposed address to His Majesty King Edward VII following the death of Queen Victoria. Ordinary meetings on the other hand had no regular pattern of assemblage until Colonel Pennycuick's arrival. He established the rule that such meetings should be held on the first Monday in every month. Matters for discussion were to be inserted in the "Agenda Book" but Ottley found that after he held six meetings "no single entry has been made in the Agenda Book by any of my colleagues, and hence there was nothing to discuss". This reply is conspicuous for what it did not say, and appears to support the view taken by the press that since his arrival at the College, Colonel Ottley held himself aloof from his colleagues. In his first sixteen months at Cooper's Hill he held eleven Board meetings of various kinds and although he may have taken his colleagues' opinions he did not reciprocate by an open expression of his own views or intended reforms.

In the press the call for inquiry continued to grow and was supported by an editorial in "Nature" which appealed "to men of science and of learning to make, either by deputation or by memorial, a representation to the India Office of the widespread feeling of disapproval with which this official action ... is regarded, and of the desirability of ensuring to the educational staff of the College at Cooper's Hill such influence in educational matters as is accorded in every College in the Kingdom". Many writers argued that the question of the injustice to the Cooper's Hill Professors could not be separated from the
interests of science generally, and the widespread indignation aroused by the dismissals was soon harnessed in the form of a Memorial, circulated by Lord Kelvin to all the United Kingdom Universities. The Memorial stated inter alia that "such arbitrary dismissal is likely to affect adversely the cause of scientific teaching in the United Kingdom. It cannot fail to injure the future of the College. During the correspondence which has ensued it has become apparent that the teaching staff have no voice in the educational policy of the College and are not consulted when any change in the curriculum is contemplated. We wish to draw the attention of the Secretary of State to this unsatisfactory state of affairs which must militate against the success of the College as an educational centre". By the 27th January the Memorial had collected 350 signatories of whom 150 were Fellows of the Royal Society. Indeed it is ironical that one of the signatories, Sir Douglas Fox, was, in his capacity as the President of the I.C.E. ex officio, a member of the Board of Visitors at Cooper's Hill from November 1899 to November 1900.

Faced with a Memorial signed by so many of the most distinguished scientists in the United Kingdom, some of whose names were household words in the world of science, Hamilton had little alternative but to invite a deputation to the India Office to discuss the dismissals and their significance. In consequence a Deputation headed by Lord Kelvin and consisting of Lord Lister, Lord Rayleigh, Sir F. Branwell, Sir F. Abel, Sir Norman Lockyer, Sir W. Crookes, Professor H.E. Armstrong, Professor Poynting, Dr. G. Johnstone Stoney, Professor Meldola, Professor Perny and Professor Everett waited on the Secretary of State for India on the afternoon of the 12th February 1901. This was one of the most powerful and representative deputations ever to wait on a Secretary of State but they received little satisfaction from
After presenting the Memorial to which there were then 374 signatures Kelvin went on to read letters from those who were invited to be part of the Deputation but who were unable to be present. Sir J. Batty Tuke wrote that he felt strongly "that gross injustice has been done". Sir R. Jebb thought that the summary dismissal of the teachers at Cooper's Hill was extremely hard and inconsiderate to them, "derogatory to science, and likely to injure the public service by deterring highly educated men from coming forward for such posts". Sir Douglas Fox wrote "As one of the Governing bodies at Cooper's Hill from November 1899 to November 1900 I received no notice whatever of the proposed drastic change in the teaching staff". In a subsequent letter he wrote that certain changes were suggested to the Board of Visitors but they involved superseding the services of only two of the staff and he was astonished to find that seven of the staff had been dismissed without warning.

Lord Kelvin said that the object of the Memorial was to protest earnestly in the public interest against the proposal for the sudden and arbitrary dismissal of half of the teachers in the department of engineering and to call attention to the need for a better method, in the future, of making reforms in the curriculum, and to express a hope that the proposed dismissals would be countermanded. "Cruel injustice would be done to capable and loyal public servants if they were dismissed without it being proved to be absolutely necessary for the efficient and economical working of the College". Kelvin disapproved of the secrecy and haste with which the dismissals were carried out and indeed had a letter from one of the dismissed teachers which declared: "It has been a blow in the dark. No one had any conception that such a calamity to
individuals and such a blow to the College and to education was impending". In commenting on the subjects which it was proposed to remove from the curriculum Kelvin noted that if the Board of Visitors were responsible for the proposals, then what was more advisable was the dismissal of the Board of Visitors.

Lord Lister noted that it was "an exceedingly strong step" to dismiss the seven teachers without any real reason and almost at a moment's notice. Such a step was calculated to discourage men from devoting themselves to a course of science, and anything which had that effect was nothing less than a national calamity. On the subject specialities of the dismissed teachers he expressed the view that, to any man proposing to devote himself to the practice of any branch of applied science, a thorough grounding in the fundamental sciences was of crucial importance. Lord Rayleigh argued that unless posts of this kind were made reasonably secure it would be impossible to obtain men of the right stamp to fill them. Similarly, Sir Henry Roscoe maintained that the dismissal of these men was subversive of the interests of science and prejudicial to the College itself.

Professor H.E. Armstrong spoke on behalf of colleagues in science who felt the action of the Government to be "a positive affront". On the other hand Dr. C.J. Storer noted that although the appointments were tenable with the proviso of three months' notice without cause assigned on either side, this proviso was only to prescribe the method of dismissal if the work was not efficiently done, whereas the dismissal document expressly recognised the value of their services.

In reply Lord George Hamilton declared that the great mass of the Memorialists had, under some misapprehension attached
their names to the Memorial. He had the honour of seeing a number of gentlemen whose names were universally known as investigators in original science, and who had made discoveries of the utmost benefit to mankind. However he ventured to point out that the Memorial would reverse the process by which they had achieved fame. That fame was based on an investigation into the phenomena of facts whereas the memorial asked for an enquiry - but every speaker had pronounced confidently on the subject on which he asked for investigation. Lord Hamilton pointed out that he had not seen the dismissed teachers Memorial until the newspaper agitation was begun, but he would place the facts before the present deputation.

The first 'fact' that Hamilton stated was that Cooper's Hill College was not a financial success. In attempting to keep pace with the advancement of science and engineering it was certain that the College would impose a burden on the revenues of India. Indeed he declared that "from the outset the College had been a financial failure as although an apparent equilibrium had been established during the last few years, the whole of the interest on the capital invested had been a permanent burden on the revenue of India".60

He quoted the 1895 Report which noted that the teaching staff was out of all proportion to the number of students they had to teach but there was then no enquiry into the efficiency of the education given. Moreover, shortly after he became Secretary of State he was informed that the College was not in a satisfactory state either as regards teaching or discipline, and that the best thing to do would be to abolish the College altogether. This he refused to do and shortly after Colonel Ottley became President he submitted a report on certain necessary reforms.
The Memorialists wanted an inquiry by competent persons but the Secretary of State quoted the names of the gentlemen forming the Board of Visitors and mentioned their various qualifications. These gentlemen had gone through every proposal made by Ottley and despite Sir Douglas Fox's observations they had been unanimous in their approval of his report.

He then entered into the detailed cases of each of the dismissed teachers, and the terms of their employment. The terms of Mr. Reilly's engagement in the Mechanical Laboratory were a month's notice on either side. His salary was £150 a year and he would receive a gratuity of £75. Mr. Hurst was a retired War Office accountant, seventy-two years of age and in no sense a member of the permanent staff. He was not entitled to any compensation but they offered him £50 gratuity. Professor McLeod was no doubt the most distinguished of the teaching staff whom it was proposed to dismiss. He had been at Cooper's Hill some thirty years and as such was entitled to a retiring allowance on the Civil Service Scale. Indeed he would be sixty years of age in February 1902 and under Civil Service rules would then have to retire. They proposed to give him the maximum pension of £466 and a gratuity of £185, whilst his assistant in Chemistry was amply competent to give all the instruction that the new time-table would allow.

Turning to electrical engineering, which subject it was proposed to make compulsory, this change necessitated the retirement of Mr. Stocker and Mr. Shields. Mr. Stocker whose salary was £450 would receive a pension of £120 and a gratuity of £125 while Mr. Shields whose salary was £400 would obtain a gratuity of £525 in lieu of a pension. The last two cases involved placing the teaching of engineering under a single professor and the most competent person for that position was Dr. Brightmore.
This necessitated the retirement of Mr. Hearson and Mr. Heath: the former was not entitled to a pension but they were giving him one of £150 and a gratuity of £165 - the latter was so entitled and he would receive the maximum pension that could be granted of £273 and a gratuity of £135.

In thus attempting to point out that exceptional consideration had been shown to all, the Secretary of State hoped that they would not become an obstacle to reform, and that the personal considerations of those who teach should not predominate over all other considerations. Thus "the Government cannot for a moment admit that any gentleman engaged in scientific teaching is to have such vested interests in the permanence of the post he holds that he is to hold it quite regardless of the terms or conditions of the engagement into which he has entered. Such a position is an impossible one and therefore I cannot hold out to you any hope of going back on the decision which has been conveyed to these gentlemen".62

The deputation then withdrew with Lord Kelvin expressing disappointment at the nature of the reply. The following day Kelvin circulated a letter to the "Times", "Morning Post" and "Standard", with a copy for Lord George Hamilton, in which he stated, "what I ought to have said if I had sufficient presence of mind, instead of merely expressing disappointment when I talked to you yesterday, on the part of the deputation".63 In this letter Kelvin declared that the answer given to the Deputation had been "far from satisfactory" as it gave no reason to believe that any one of those threatened with dismissal had been found in any respect incompetent or negligent in the performance of duty. Nor had Lord George Hamilton proved that any alterations in the College could not have been carried out with the present teaching staff "with perhaps some moderate
change in the allocation of their duties". Kelvin therefore hoped that the Prospectus issued on the 1st January 1901 which promised the existing allocation of subjects should hold good until the end of the session.

Throughout February the newspaper agitation continued unabated despite the India Office leaking "the official version of the facts" to the "Standard" on the eve of the Deputations interview with Lord George Hamilton. Indeed in anticipation of questions in Parliament the Secretary of State prepared a Blue Book of "correspondence relating to the remodelling of the studies and the retirement of certain Professors and lecturers" which was presented to both Houses on the 21st February (although many members did not receive copies until the 29th February). Dissatisfied with the Blue Book's contents the University Members formed a Deputation to interview Lord George Hamilton in the Commons on the evening of the 5th March, which consisted of Sir William Anson (Oxford University); Sir Michael Foster (London University); Sir Richard Jebb (Cambridge University); Mr. William Lecky (Dublin University) and Mr. John Talbot (Oxford University). The Deputation observed that a teaching staff of long experience, willing and competent to teach, had suddenly found their scheme of studies altered and some of them dismissed without even a hearing by the President and with no opportunity of an appeal to the Board of Visitors. They declared "many persons eminent in science have expressed strong opinion that the proposed dismissals will act injuriously on the scientific education of the country. These opinions cannot be disregarded and the Members for the Universities who have no other object in view in this matter than the advancement of higher education are bound to press for a reconsideration of the subject by such
In preparation for receiving the Deputation the Secretary of State requested the advice of his Under Secretary, Sir A. Godley, and was informed that "if the Secretary of State in Council is not allowed to manage the College with a simple eye to the requirements of India in the Public Works and Forest Departments, it will have to be closed". This advice was based upon a consensus of opinion within the Council of India that Cooper's Hill was not a University or a College for the advancement of science. It was a training school designed to prepare men for Indian work of a very special and peculiar kind. Consequently the best judges of what was wanted were not men of science but men who knew by actual experience what the duties and requirements in India were - such as Colonel Ottley and the Board of Visitors. "They look at the matter practically and in the interests of India; not in the interests of science, and still less in the interests of scientific individuals". Therefore, "if we are not allowed to ... manage our own College for our own purposes in our own way, we prefer to shut it up and to recruit our P.W.D. otherwise henceforward".

The Council of India plainly resented this 'outside' interference in an 'internal' affair and it was clear that the necessary funds for maintaining the College would not be forthcoming if control of the College was taken out of the hands of the Secretary of State, or, if he was called upon to maintain a College in England for the advancement of science, at the expense of India. Hamilton however was opposed to the idea of closure and in reply to the Deputation he observed that the channels of communication between the teachers, President and Visitors should be widened and quickened. "A divergence of opinion such as has been revealed is detrimental, if not fatal,
to harmonious co-operation. He therefore proposed to ask the Universities of Oxford, Cambridge and London to each nominate a Visitor, to be in addition to the existing Board and to ask the reconstituted body to appoint a Committee (including the University representatives) to inquire into and report upon the working, discipline and constitution of the College, and the relations of the Visitors, President and teaching staff. Meanwhile he instructed the existing Board of Visitors to meet at once and hear what the dismissed teachers wished to argue against the changes.

The Board of Visitors held three meetings at the India Office on the 14th, 19th and 21st March 1901 where they not only examined the seven dismissed teachers, but also, Messrs. Ottley, Brightmore, Woods, Minchin, Lodge, Hicks, Matthews and Groom. They reported on the 25th March and confirmed the need for changes in the course of instruction which were to be carried out. The changes involved the retirement of Messrs. McLeod, Hearson, Heath, Shields, Reilly and Hurst and they were to be given the pensions mentioned above, (page 275). However in the case of Mr. Stocker they noted that the instruction in Physics (which had previously been restricted to the first two years) should be extended to students in the third year. In consequence Stocker was to be retained as Professor of Physics "until further experience has been gained", as the new lecturer in Electro-Technology might not be able to devote sufficient time to the teaching of Physics. In his evidence to the Board Ottley consolidated the changes in Engineering by proposing that he himself would take a share in teaching that subject. The new arrangement was: Brightmore to take 'water supply', Woods to teach 'railways and sewerage schemes' and Ottley to take 'theoretical and practical canal engineering'.72
Although the new scheme of studies reflected, almost entirely, Ottley's scale of preference, the individual submission to the Board of Visitors revealed a highly unsatisfactory state of affairs in the internal politics of the College. A series of groupings or factions had developed since September 1899 and it was evident that the President had taken soundings from some of the teachers but not from others. By March 1901 the College was "humming round like a hive of disturbed bees" and it was clear that swift action was needed to rid the College of the internal turmoil and to establish normal relations. The appeals of six of the seven dismissed teachers were rejected and Ottley looked forward to the Easter vacation for a completely fresh start. He noted "I shall be able to count as friends and devoted followers and colleagues: Brightmore, Woods, the survey men, Hicks, McElwee, Hay, Tickell, Boyes, Schlich and Hutchinson. As neutral I should count three: Fisher, Stocker and Lodge, and in opposition: Minchin and Groom - the latter being a temporary man. You will see therefore that there is every reason to believe that we are commencing a period of peace and happiness and I think Cooper's Hill will boom".

When the students reassembled after the Easter vacation many familiar faces were missing from the staff, especially that of Professor McLeod. No generation had known Cooper's Hill without him and thus the one remaining link with the earliest history of the College was snapped. He left behind him a record of conscientious and devoted service and although he had never taken any academic degrees he had risen to the very summit of his profession.

Under the new conditions the students quickly settled in to the work of the term, with three new teachers: Messrs.
Meanwhile in the course of the inquiry into the reforms at Cooper's Hill which they had just concluded, the Board of Visitors had again raised the question whether sufficient reasons still existed for the maintenance of the College. In a well argued Report the Board of Visitors noted that before the nominees of the Universities of Oxford, Cambridge and London were appointed to the Board, the Government would be well advised to consider the strong arguments against the maintenance of the College. This advice was not sought by the Secretary of State and consisted of a five pronged attack on the College.

Firstly, the Board argued that whatever reasons existed in 1871 for the establishment of an engineering college under Government control it was possible that those reasons no longer existed. Since the essence of reasons was the relative absence of scientific education for engineers in Britain in 1871, the Board pointed to the growth of engineering education in the last quarter of the nineteenth century and to the excellent facilities which existed in Colleges affiliated to the Universities of London, Cambridge, Glasgow, Dublin, Victoria, Birmingham and others. Secondly, that much inconvenience resulted from Government undertaking the administration of an educational College, and unless absolutely necessary it was to be deprecated. Thirdly, that the limitation of Indian appointments to Cooper's Hill College prejudicially restricted the choice of Government in filling various posts. Fourthly, that the education given at Cooper's Hill was highly expensive amounting to a total annual cost of some £280, which prevented the sons of Indian officials from
following their fathers steps, whereas they could obtain an equally good but much less expensive education at University. Finally, that the College did not pay its way, much less any repayment on the capital cost. "The receipts and expenditure can only be made to balance by crediting the College with fees in excess of the actual cost for testing materials for Indian Railways". 

Despite this apparently copper bottomed case against the College the Secretary of State was "not disposed at the present moment to raise the question of the abolition of the College", as the educational reforms just agreed to had not yet been tried. He therefore proceeded with the enquiry he had proposed to hold on the constitution and working of the College by expanding the Board of Visitors. Nevertheless the maintenance of the College was to be regarded "in the light of an experiment, the continuance of which can only be justified by its success".

The three University nominees, Dr. A.R. Forsyth (Cambridge), C.C. Bourne, Esq. (Oxford) and Sir G. Busk (London) were appointed in May 1901 and no consideration was given to the possibility that as University representatives their interests might be prejudicial to the future of Cooper's Hill (despite the fact that Dr. Forsyth had protested against the dismissals by signing Kelvin's memorial). The reconstituted Board of Visitors immediately formed a committee of seven members at a meeting on the 4th June 1901, to inquire into and report upon the working, discipline and constitution of the College and the relations of the visitors, the President and the teaching staff. Their terms of reference specifically excluded "any inquiry into the course of study pursued at the College, or into the methods of teaching". These were matters which had just been
considered and decided upon and the Secretary of State clearly did not want to re-open the subject.

The Committee of the Board of Visitors reported on the 12th July 1901 with proposals for increasing the lines of communication between the President, teachers and Board of Visitors. These proposals included (a) the Board of Visitors to meet at the India Office once a quarter instead of, as previously, on an ad hoc basis, and (b) the College Board to consist of the President and the senior professors (Engineering, Mathematics, Natural Science and Forestry) to meet once a month when the decision of the majority would prevail, and that the College Board should have the power to summon the whole teaching staff for consultation on matters connected with the general interests of the College. The existing standing orders which were of "too military a character" were to be revised and when the next appointment of President was made they thought it important "to attach weight to educational experience".

Although the Committee refrained from discussing whether the maintenance of the College was any longer necessary or desirable as the best means of obtaining recruits for the I.P.W.D., they nevertheless provided evidence that if the College were continued further substantial sums would have to be invested to bring the College up to the most modern standards. Thus "the equipment of the R.I.E.C., having regard to the present standard of scientific education, is defective. If the education given at the College is to be made thorough and sufficient, a considerable expenditure must be sanctioned without loss of time for the provision of more lecture rooms, of models, of instruments and other appliances, without which engineering cannot be properly taught". These facilities
were particularly urgent for the new department of electro-
technology, but, in an additional memorandum - based upon their academic experience - the three dons called for "considerable capital as soon as possible" and pointed out that additional sums would be necessary from time to time to meet the frequent changes in both subjects and apparatus. 85

Consequences of the Enquiries

The immediate effects of Ottley's report and the subsequent investigations by the Board of Visitors were that Cooper's Hill became a topic of discussion in Parliament. Questions were raised on no less than eight separate days in 1901 concerning the College and two Parliamentary Blue Books submitted on the dismissals. A third was submitted in January 1902, embodying the Report of the expanded Board of Visitors.

The cumulative financial effect of the reports was that substantial capital was expended on the College amounting to £7,324 in 1901, £15,253 in 1902 and up to March 1903 a further £8,565 had been spent. In the three years a total of £31,142 had therefore been spent on capital account which was composed chiefly of £13,235 for general restoration of buildings; £3,312 for sanitary works; £4,097 for a mechanical laboratory and carpenters shop with apparatus, and £5,882 for an electro-technical laboratory and apparatus.

Thus in financial terms the total capital expenditure on the College up to the 31st March 1903 amounted to £167,578 which, at an interest rate of three per cent amounted to £5,028 approximately per annum. However, this was not the end of such expenditure as by that date plans were in preparation for a further new block of buildings comprising new lecture rooms and a geological museum, the cost of which, if carried out, would amount to £16,000. 86 The fittings for these buildings were
The new Electro-Technological Laboratory.
estimated to cost an additional £4,000. Plans and estimates were also in preparation for a new laundry and baths, calculated not to exceed £12,000 and further sanitary work in connection with the outbuildings of the College estimated at about £5,000. To this was to be added the cost of a drill hall (maximum of £3,000) and an unstated amount for further restoration work on the College. Even this was not the end of the matter as further demands would be necessary from time to time for the College to keep pace with developments in engineering education and because the equipment of the laboratories and workshops needed to be maintained at a high standard of efficiency (with no possibility of utilizing a capital depreciation account).

In consequence further capital expenditure of some £40,000 was anticipated in the immediate future bringing the total spent on capital account since 1900 to approximately £71,000 with no plausible return. Expenditure on this massive scale was certain to evoke the wrath of Parliament especially since the reforms of 1901 (and subsequent dismissals) were implemented with a view to economy. In consequence the Secretary of State established a small, but high powered, Committee of Inquiry on the 12th May 1903 to report upon "whether it is or is not expedient, under existing circumstances, to maintain the College at Cooper's Hill". If this question was answered in the affirmative then the Committee were to suggest measures to improve the quality of the recruits selected and trained, and, if it was answered in the negative then they were to suggest alternative methods of recruitment to the Indian Public Works and Forest Departments.
Towards dissolution

The Committee consisted of the Chairman of the Public Works Committee of the Council of India, Sir Charles Crossthwaite (as Chairman), and one Member of Council, Sir James L. Mackay. Three other members were appointed, viz. Sir William Arrol, the Liberal Unionist M.P. and distinguished engineering contractor; Professor Arthur Rücker, Principal of the University of London and formerly Professor of Physics at the Royal College of Science; and, Sir Thomas Higham, previously Inspector General of Irrigation to the Government of India and author of "Hydraulic Tables".

Altogether the Committee held ten meetings half of which were taken up with examining witnesses, and the other half with visits to Cooper's Hill, the Central Technical College, the City and Guilds of London Institute and the engineering Laboratory at Cambridge. Their unanimous report (submitted on the 17th August 1903) concluded that it was not expedient to maintain the College. The Committee considered the general advantages of the College to be that:

(a) special instruction given for Indian needs;
(b) the College brought together men who were destined for an Indian career;
(c) an opportunity was thus afforded of rejecting unfit or undesirable candidates.

However for each particular advantage there were substantial arguments to the contrary. The Committee addressed a circular to the following fifteen Universities and other Institutions with Departments of engineering:

Cambridge University
University College, London
King's College, London
Royal College of Science, London
City and Guilds of London Institute
Owen's College, Manchester
Yorkshire College, Leeds
University College, Liverpool
Birmingham University
Durham University
Edinburgh University
Glasgow University
University College, Dundee
University College of South Wales and Monmouthshire, Cardiff
Dublin University.

The circular enquired:

(i) the opinion of each institution as to whether there would be any difficulty in obtaining annually some 28 qualified men, of 21 to 24 years of age, for the I.P.W.D., were the R.I.E.C. to be abolished;

(ii) the number of candidates likely to come forward annually from each institution;

(iii) the amount of annual fees and the estimated cost of lodging and subscriptions;

(iv) the duration of the course.

Not surprisingly (as most of the institutions had petitioned against the establishment of the R.I.E.C. in 1871 as being inimical to their interests) the universal reply was that there would be no difficulties as to qualifications or numbers, and that the annual fees and cost of living were lower than those at Cooper's Hill. When viewed against this background the 'special instruction' transpired to be in the system of Public Works Accounts - a subject the Committee felt to be of over exaggerated importance.

Against the advantage of bringing together men intended for an Indian career and the fostering of 'esprit de corps' and comradeship the Committee set the isolated position of Cooper's Hill and the consequent exclusion of the young (at an impressionable age) from the wider sphere of influence which education at a University affords. Similarly they felt that the opportunity of rejecting unsuitable candidates was over emphasised as a detailed examination of the history and character of candidates for service in India should be an
effective safeguard.

On the other hand the Committee argued with the Board of Visitors Report of 1901 that there were definite disadvantages in maintaining the R.I.E.C. Firstly "much inconvenience results from the Government undertaking the administration of an educational College, and that, unless there be an absolute necessity for such a course, it is to be deprecated". Secondly the high cost of education and maintenance of students restricted competitors at the entrance examination and therefore tended to lower the standard of qualification of those eventually admitted to Indian appointments. Thirdly the College supplied only a small number of men each year to India, and clearly, as the circular replies revealed, such a small number could easily be recruited from other sources. Fourthly the Committee calculated that "the net result of working the College for the whole period since its opening is a deficit of £48,345. Inclusive of simple interest at three per cent per annum on capital outlay, the net result for the whole period is a deficit of £170,643".

So far as the R.I.E.C. school of Forestry was concerned the Committee asked Dr. Schlich, "is there any forestry reason for maintaining Cooper's Hill College?" He replied "None. I am one of those theoretically in favour of a University education, because I believe the advantages of a University education are so considerable that even the so-called esprit de corps of the special college cannot for a single moment be placed against it as a 'quid pro quo'. As regards forestry, especially, I think Cooper's Hill has disadvantages, because various branches of science are there taught for the special requirements of an engineer, which are, to a considerable extent, different from those which a man who wishes to become a really scientific forester should acquire".
Equally, although Telegraph students had a more logical connection with the College, the requirements were so few that the Government could easily obtain their supply from the open market and the College should not be maintained only for that purpose. The burden of evidence against the College was therefore so overwhelming that the Committee unanimously recommended "that the Royal Indian Engineering College should be closed".93

The Secretary of State (Lord George Hamilton) immediately despatched copies of the Report to the Governor General of India in Council (11th September 1903) and asked for the views of the Government of India before taking any action.94 Later in that month Lord George Hamilton (and Lord Ritchie) resigned from the Cabinet (as free traders) on the fiscal issue 95 and was succeeded in the post as Secretary of State for India by the Rt.Hon. St. John Brodrick. In October Lord Curzon and the five members of Council replied (in a 3,000 word letter) to the new Secretary of State protesting at the intended College closure, and stating that the Indian Government would be willing to bear any increase in expenditure necessary both to reduce fees for the students and to purchase further apparatus. Indeed the Government of India declared that "there is no necessity for the College to be self-supporting. Efficient engineers are the essential requisite, and for these the Government of India is prepared to meet the necessary cost".96

The new incumbent faced with the balance of two opposing views had to decide whether the unanimous views of the Government of India were entitled to greater weight than the unanimous views of the Committee of Inquiry. In these circumstances it is hardly surprising that the matter was held
in abeyance for some three to four months but towards the end of February 1904 the decision could not be postponed any longer.\textsuperscript{97} At a meeting on the 1st March 1904 the motion was put to the Council of India "that Cooper's Hill College be not maintained".\textsuperscript{98} The composition of the Council of India at that date was:\textsuperscript{99}

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secretary of State</td>
<td>St. John Brodrick *</td>
</tr>
<tr>
<td>Under Secretary of State</td>
<td>Sir Arthur Godley</td>
</tr>
<tr>
<td>Under Secretary of State</td>
<td>Rt. Hon. the Earl of Hardwick</td>
</tr>
<tr>
<td>Assistant Secretary of</td>
<td>Sir Horace G. Walpole, K.C.B.</td>
</tr>
<tr>
<td>State</td>
<td></td>
</tr>
</tbody>
</table>
| Members of Council        | Sir John Edge, K.C., President.\textsuperscript{\top}
|                           | Sir Charles H.T. Crosthwaite * ✓          |
|                           | Sir Stuart C. Bayley * ×                  |
|                           | F.C. Le Marchant * ✓                      |
|                           | General Sir J.J. Gordon, K.C.B.* ✓        |
|                           | Sir Dennis Fitzpatrick, K.C.S.I.* X       |
|                           | Sir James L. Mackay, G.C.M.G., K.C.I.E.* ✓|
|                           | Sir Philip P. Hutchins, K.C.S.I.* X       |
|                           | Sir William Lee-Warner, K.C.S.I.* ✓       |
|                           | J.F. Finlay, C.S.I.* ✓                    |

Those marked with an asterisk were present at the meeting, those who voted for the motion are ticked; those against are marked with an x. In consequence the decision to abolish the College was carried by six votes to four and the Public and Public Works Committees were empowered to take the necessary steps to give effect to this decision.

Ironical features of the 1903 Inquiry

It is ironical that the 1903 Report was the direct result of Colonel Ottley's 'secret' report upon curriculum reform at the College, and the indecent haste with which it was proposed to dismiss the seven affected teachers. The Committee visited the College for only 2\frac{1}{2} hours and asked Colonel Ottley some 203 questions in 105 minutes, and when they had concluded their deliberations he was not informed of their findings.
Indeed in March 1904 an article appeared in the "Indian and Eastern Engineer" entitled "The Royal Indian Engineering College, Cooper's Hill, by Colonel J.W. Ottley, C.E.,R.E." which amounted to an advertisement to attract potential students.

All arguments in favour of the College were easily preempted and demolished by the use of the statistical data gleaned from the circular enquiries, although the amount of disinterested evidence (i.e. excluding teachers at Cooper's Hill or those at other educational establishments) was not totally in favour of abolition. Finally, when the matter came for decision before the Council of India and was carried by six votes to four, two of the principal architects of the report were entitled to vote for abolition.

It is also ironical that the Government of India's position had changed regarding the financial liability of the institution, (cf. infra. Chapter 3, p.108, and Chapter 6, p.289) as they now had the benefit of some thirty years of experience with the College alumni occupying every rank within the I.P.W.D.
Towards Closure

The decision to close Cooper's Hill was formally communicated to the President of the College on the 25th April 1904, and in this letter it was noted that the Secretary of State had "regretted" that "this measure should have been considered necessary in the public interest". Exceptional consideration was to be shown to all members of staff in the payment of compensation and gratuities but once the decision was taken there was no delay in its implementation. By October the buildings and estate of Cooper's Hill were in the hands of "Cluttons", the well known estate agents, with a view to sale, and the staff were actively in search of alternative employment. Alfred Lodge, Professor of Pure Mathematics since 1884 was offered and accepted a Mathematics post at Charterhouse School, Godalming, and was replaced (in October 1904) at Cooper's Hill by Richard N. Haygarth from Queen's College Cambridge. At the same time, Dr. Alfred Hay, Professor of Electro-Technology, left the College to head the Physics and Electrical Engineering Department of the Hackney Technical Institute, (the lecture and Laboratory work at Cooper's Hill being undertaken by his demonstrators Messrs. Atchison and Templeton); and the posts of Secretary and Bursar were abolished thus displacing Lieutenant-Colonel W.J. Boyes and Mr. Charles Tickell respectively.

The last entrance examination was held in August 1904 and the College course for the successful candidates was to extend over two years instead of the normal three years, but in the case of engineering students it was extended into October 1906 with a view to preparing for the examination of the Institution of Civil Engineers in that month. In October, 48 new students entered bringing the total in the College to 123 students in residence but in July 1905 the Forestry Department
was removed en masse to Oxford University. Dr. Schlich and Mr. Fisher left in the summer to establish the new Department there and were followed later in the year by Captain Mackenzie to lecture in the schools of Forestry and Geography.

In October 1905 the College commenced its final session with sixty-four students in residence, and nine 'third year Foresters' (still on the register) completing their course in Germany. It is notable that of those in residence only 35 played Football (under Association or Rugby Rules) and all were greatly concerned to do what they could - by abandoning soccer - to uphold the long-standing reputation of the College for Rugby Football.

Colonel Ottley, who had been appointed by the King to be Knight Commander of the Order of the Indian Empire in June 1904, remained in residence during 1906 to arrange for the disposal of the College property. The machinery and accessories were distributed between the National Physical Laboratory, the Indian Stores Department and India. The property of the Boat and other clubs was sold by private treaty and the money thus realized together with the Recreation Fund balance, was given to the "Cooper's Hill Society" under the Presidency of Sir Alex Taylor. This Society of College "Old Boys" met annually after the College closed and by 1912 the total number of members had reached 816.

The following "Hour of Farewell" provides an interesting though sad reflection on the College:

"The Hour of Farewell" 106

Through years to be the Thames will flow,
With winter flood and summer stream,
But faces that it used to know
Will pass away as in a dream.
Unbroken silence now will cling
Where joy and laughter used to ring.
As each succeeding year passed by,
  Fresh sons were nourished by your hand
Till now you are condemned to die
  By those who fail to understand.

    The Nation, scorns your school and meads;
    What Nation knows its Empire's needs?

They founded you to undertake
  A task that others could not do,
And gladly for the Empire's sake
  You cultivated pastures new.

    Now rivals whom you've always led
    Are called to do your work instead.

So we must bid a fond farewell
  With gratitude that is your due,
This saddened thought on which to dwell
  Tomorrow has no place for you.

    But all the sons o'er whom you sway
    Look back with thanks on yesterday.

    H.I.B., June 1904.
Conclusions

Cooper's Hill was formally closed on Saturday the 13th October 1906 but throughout it's thirty-five years of existence it is doubtless that the College made a most important contribution to the development of engineering education in this country. Writing in the "Electrical Review" of March 1905, Rollo Appleyard declared that the College "has been a potent factor in raising the standard of engineering schools; it has set the pace and it has attained the position of being the premier Engineering College of the Empire". Even at its most minimal level, the establishment of the College forced other institutions to rethink their level of commitment to engineering education at a decisive period in their history and in many ways its ultimate eclipse may be viewed as part of that contribution.

Unlike other Colleges, however, Cooper's Hill was uniquely burdened with the need for financial equilibrium and as such it contained the germ of its own destruction. Plainly the revenues which were appropriated for the purposes of the Government of British India, could not, without a clear breach of justice, be applied for the general education of engineers in this country. In consequence the College could not expand as a general engineering College affiliated to a University, whilst on the other hand, fees could not be reduced to attract more students.

Although severely constrained by the numbers of engineers required for the I.P.W.D. (especially after the Second Afghan War) the College managed to alter the method of selection from a competitive examination followed by a series of pass examinations to a pass entrance succeeded by a number of competitive trials.

Unfortunately at the time of its abolition the practical
benefits of the College were only beginning to be felt, for example, in July 1903 for the first time in the history of the Madras P.W.D., the Chief Engineer, the Chief Engineer for Irrigation and the Consulting Engineer for Railways were all Cooper's Hill men. At the final prize day in July 1906, Sir John Ottley declared: "The Royal Indian Engineering College may be abolished, but the name of "Cooper's Hill" will live in the monumental works erected in India by her sons."
Footnotes.


3. Extracted from "Reports and Correspondence relating to the expediency of maintaining the Royal Indian Engineering College, and other matters". Cd.2055 of 1904, Appendix VII, p.43.

4. Entries in the Main Ledgers under 'Engineering College' (starting 1OR/L/AG/7/1) were first begun in 1874/75 and gave monthly totals of receipts and payments. However for details it is necessary to refer to Miscellaneous Payments Books (1OR/L/AG/4/1 ...) and Cash Receipt Books commencing 1OR/L/AG/5/1 ...

5. Letters written by or on behalf of Secretaries of State for India, in this period, are generally to be found in the series 1OR/MSS/EUR/F.102 which includes letter books from 1883 to 1909. However for ease of retrieval and consultation, where a letter is used in Parliamentary Accounts or Papers the Parl. Paper in question is cited. See Letter from Horace Walpole to Sir A. Taylor, dated 12th February 1894 in "Correspondence Relating to the remodelling of the studies and the retirement of certain of the Professors and Lecturers" - Hereafter referred to as cd.490 of 1901, p.s.


9. Extracted from Appendix VIII of Cd.2055 of 1904, (op.cit. footnote 3) p.44.


14. Cd.490 of 1901, Appendix E to No.4 (footnote 6), pp.16-17 (Report of Mr. A.C. Scott).


17. Ibid, p.11.

18. Ibid, p.11, "Note by Mr. Leonard".

19. Ibid, p.12, "Note by Sir Charles Bunard".


21. The 'Register and Indexes' of the Public Works Department (1OR/Z/L/PWD/ series) indicate that the documents relating to the choice of Taylor's successor were "lost or destroyed".

22. "Indian Engineering", 1st August 1896, p.68.

23. See the Secretary of State's notes in anticipation of a question in Parliament in 1OR/L/PWD/6/560 F.984.

24. Ibid.

25. In a letter to the Secretary of State, dated 12th August 1899, Pennycuick declared Brightmore's appointment to be a "serious mistake". See 1OR/MSS/EUR/F.102/2, p.2. Pennycuick elaborated upon his view that Brightmore did not have the experience necessary for the post in an interview with the "Indian and Eastern Engineer", (November 1899, pp.363 and 364).


29. Extracted from *Cd.2055 of 1904* (op.cit. footnote 3), Appendix V, p.41.


31. Supplement to "Notes by the President" or "Canal and Railway Construction" dated 16th February 1900 (*Cd.490 of 1901*, p.21).

32. Ibid, p.21, para.4.

33. Included as No.7 in *Cd.490 of 1901*, pp.22-34.

34. Dr. Matthews timetable is included as 'Enclosure 2 in No.7' of *Cd.490 of 1901*, p.36, and Ottley's comments upon the timetable are on pp.22-23.
35. Infra Ch. 4, pp.174.

36. Professor Hearson's proposals were dated 29th March 1899 and are included as Appendix A to a "Note by Sir C. Crossthwaite, K.C.S.I., on the rearrangement of the studies and consequent reduction of the teaching staff at Cooper's Hill" dated 1st February 1901. Pennycook did not propose any change until Professor Hearson had retired! See 1OR/MSS/EUR/F.123/45.


38. Ibid, p.25. No other branch of applied science had made such rapid progress in the last quarter of the nineteenth century. By 1900 electric light and power stations were established in all the more important towns throughout Britain, and electric traction had been introduced on the more important tramway and suburban railway lines.

39. "Memorandum on educational course" (op.cit. footnote 37) p.27.

40. Ibid.

41. Ibid, p.28.

42. "Report by the Board of Visitors" dated 24th July 1900, and included as No.9 in Cd.490 of 1901. See also 1OR/L/PWD/8/20.

43. "Letter from Sir A. Godley to the President of the R.I.E.C." dated 2nd November 1900, included as No.12 in Cd.490 of 1901, pp.46-47.

44. "Letter from Horace Walpole to the President of the R.I.E.C." dated 14th December 1900, included as No.15 in Cd.490 of 1901, pp.48-49.

45. This letter is reproduced in "The Times", 3rd January 1901.

46. "Memorial from Mr.Hearson and Others to the Secretary of State for India in Council", dated 27th December 1900 and included as No.17 in Cd.490 of 1901, p.50. The memorial is also reproduced in "The Times" of 3rd January 1901.


49. "Letter from Horace Walpole to the President, R.I.E.C." dated 15th January 1901 and included as No.18 in Cd.490 cf 1901, p.52.


52. Ibid.

54. This Memorial and all of the original correspondence relating to it can be found in the bundle of documents referred to as 1OR/MSS/EUR/F.123/45.

55. A useful account of their deliberations is contained in leading articles in "The Morning Post", 13th February 1901; "The Times", 13th February 1901; and the "Daily News", 13th February 1901, but the most complete account is in the Secretary of State's correspondence 1OR/MSS/EUR/F.123/45.

56. 1OR/MSS/EUR/F.123/45.


58. See "The Times", 13th February 1901.

59. Ibid.

60. 1OR/MSS/EUR/F.123/45, (notes on interview).

61. In a "Note by Sir C. Crosthwaite, K.C.S.I., on the re-arrangement of the studies and consequent reduction of the teaching staff at Cooper's Hill", dated 1st February 1901, Mr. McLeod is described as "a man of high attainments and is certainly not overpaid. But he is unnecessarily good for the work. And it is extravagant to employ him to teach Chemistry to men who are going to follow the profession of engineering, and do not need more than the rudiments of the science". 1OR/MSS/EUR/F.123/45.


64. "The Standard", 11th February 1901. An article entitled "The Changes at Cooper's Hill" contains the statement, "The Secretary of State, therefore, considers it advisable that the official version of the facts should be published".

65. i.e. Cd.490 of 1901.

66. See the "Box of Lord George Hamilton's Letters", 1OR/MSS/EUR/F and also Enclosure 1 in Cd.539 of 1901.


68. Ibid, Note 7 from Sir A. Godley to Lord George Hamilton, dated 5th March 1901, entitled "for use when Deputation came this evening".

69. Ibid, Sir A. Godley to Hamilton, dated 1st March 1901, entitled "Cooper's Hill and Parliamentary Agitation".

70. Ibid, Letter of Reply dated 11th March 1901 from Lord George Hamilton to Sir William Anson. Included as Enclosure 2 in Cd.539 of 1901.
This was the subject of another Parliamentary Paper. Title: "East India (R.I.E.C.) - Remodelling of Course of Instruction and retirement of certain of the Professors and Lecturers. Report of the Board of Visitors (25th March 1901) and Minutes of Evidence taken before them". Cd.539 of 1901.

See Cd.539 of 1901, p.52. ("Ottley's evidence").

Ottley to Lord George Hamilton dated 1st March 1901 - 10R/MSS/EUR/F.123/45.

Ibid, letter from Ottley to Lord George Hamilton dated 11th April 1901, "On the state of affairs after the retirements effected".

Curry and Price had both been educated at Cooper's Hill and left to join the I.P.W.D. in 1875 and 1878 respectively. Curry had been employed almost exclusively on Railway Surveys and Construction, whereas Price had been employed on Irrigation work in the Punjab. Dr. Hay, M.I.E.E., had served an apprenticeship at Messrs. McWhirter, Ferguson and Co., Electrical Engineers, Glasgow, and then entered Edinburgh University where he gained a first class B.Sc. in Mathematics. He had teaching experience at University College Nottingham and Liverpool and was fluent in French, German and Russian. See "The Cooper's Hill Magazine" Volume III - No.6, May 1901, pp.85-86.

"Report by the Board of Visitors to the Secretary of State for India" dated 1st April 1901 and included as No.2 in "Reports and Correspondence relating to the expediency of maintaining the Royal Indian Engineering College and other matters". Hereafter referred to as Cd.2055 of 1904, pp.8-9.

The histories of individual Colleges should be consulted for evidence of such growth, e.g. H. Hale Bellot's history of "University College London 1826-1926" (University of London Press, 1929), pp.400-417. See also infra p.287

Cd.2055 of 1904, p.9.

"Letter from the Earl of Hardwicke to the Chairman of the Board of Visitors" dated 7th May 1901 and included as No.3 in Cd.2055 of 1904, p.10.

Ibid.

See Letter dated 17th May 1901 from Sir A. Godley to the Chairman of the Board of Visitors regarding "instructions regarding the proposed inquiry". Enclosure 3 in "Further Papers in Regard to the R.I.E.C.", Cd.831 of 1901. (Presented to both Houses - 16th January 1902).

Enclosure 5 in Cd.831 of 1901 "Report from the Committee of the Board of Visitors to the Board of Visitors re: working, discipline and constitution of the College".

Ibid, pp.15-16.

Ibid, p.17.
85. See the Memorandum by Bourne, Busk and Forsyth in Cd.831 of 1901, pp.17-18.
87. Cd.2055 of 1904 "Terms of Reference", p.11.
88. Cd.2055 of 1904 includes the Report and Cd.2056 of 1904 includes the "Minutes of Evidence taken before the Committee" (134 pages).
89. Cd.2055 of 1904, Appendix XI, "Replies to Circular addressed to Universities and other Institutions", pp.48-59.
90. Cd.2055 of 1904, Enclosure 2, p.8 and also p.19.
91. For financial statistics to this date see Appendix VI "Financial Results" in Cd.2055 of 1904, p.42.
94. "Despatch from the Secretary of State for India to his Excellency the Right Honourable the Governor General of India in Council", No.102 (Public) dated 11th September 1903, see Enclosure No.5 in Cd.2055 of 1904, pp.60-61.
97. At this time arrangements would have to be made either for the next entrance examination or for the closure of the College.
99. See the "India Office Register" for the composition of the Council of India in any one year.
102. For the Government of India's comments on the disinterested evidence see Cd.2055 of 1904, Enclosure No.6, p.63.
103. Cd.2055 of 1904 (op. cit.). Enclosure No.8, p.71.

104. These Associateship examinations were first introduced in 1898, and each year candidates who were old enough under the regulations of the I.C.E. presented themselves for examination. In February 1904 all candidates from Cooper's Hill passed with one of their number, L.E. Becher heading the list of 114 passed candidates, and winning the "Bayliss" prize awarded by the Institution. See 1OR/L/PUD/8/313, file 264, and also "The Cooper's Hill Magazine", Volume VI, No.3, December 1904.

105. 1OR/L/PUD/8/320, file 265/7 and file 265/7A.


108. "The Cooper's Hill Magazine", Volume VII, No.8, September 1906, p.107. "Cooper's Hill has not vanished" said Dr. Unwin at a public dinner some years later. "It remains in the fraternity of those educated there; its monuments are the great public works carried out by Cooper's Hill men in India and other countries. The service it has done to the nation is very great, and the results of the work, such as will long endure". See "General Sir Alex Taylor, G.C.B., R.E.; His Times, His Friends and His Work" by Alicia Cameron Taylor (London, Williams and Norgate, 1913) Volume 2, pp.303-304.
APPENDIX A

Secretaries of State for India 1868-1906
<table>
<thead>
<tr>
<th>Name</th>
<th>Date of acceptance of Seals of Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Duke of Argyll, K.T.P.C.</td>
<td>9th Dec. 1868</td>
</tr>
<tr>
<td>The Marquis of Salisbury, P.C. (2nd time)</td>
<td>21st Feb. 1874</td>
</tr>
<tr>
<td>The Right Honourable Gathorne Hardy, P.C. created Viscount Cranbrook, 14th May 1878 (a)</td>
<td>2nd April 1878</td>
</tr>
<tr>
<td>The Marquis of Hartington, P.C. (b)</td>
<td>28th April 1880</td>
</tr>
<tr>
<td>The Earl of Kimberley, P.C.</td>
<td>16th Dec. 1882</td>
</tr>
<tr>
<td>Lord Randolph Churchill, P.C.</td>
<td>24th June 1885</td>
</tr>
<tr>
<td>The Earl of Kimberley, K.G., P.C. (2nd time)</td>
<td>6th Feb. 1886</td>
</tr>
<tr>
<td>The Right Honourable Sir Richard Assheton Cross, G.C.B., created Viscount Cross, 19th August 1886</td>
<td>3rd Aug. 1886</td>
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<tr>
<td>The Earl of Kimberley, K.G., P.C. (3rd time)</td>
<td>18th Aug. 1892</td>
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<tr>
<td>The Right Honourable H.H. Fowler (c)</td>
<td>10th March 1894</td>
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<tr>
<td>Lord George F. Hamilton, G.C.S.I., P.C.</td>
<td>4th July 1895</td>
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<tr>
<td>The Right Honourable St. John Brodrick (d)</td>
<td>9th Oct. 1903</td>
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<tr>
<td>The Right Honourable John Morley, O.M. (e)</td>
<td>11th Dec. 1905</td>
</tr>
</tbody>
</table>

Afterwards - i.e. subsequent to date of appointment.

(a) " (by creation) Earl Cranbrook
(b) " (by succession) Duke of Devonshire
(c) " (by creation) Viscount Wolverhampton, G.C.S.I.
(d) " (by succession) Viscount Midleton
(e) " (by creation) Earl of Midleton, K.G.
(f) " (by creation) Viscount Morley of Blackburn, O.M.
APPENDIX B

Academic Staff of the R.I.E.C.
ACADEMIC STAFF OF THE R.I.E.C.

PRESIDENTS

Lt.-Col. George Tomkyns Chesney, R.E. 1871-1880
General Alexander Taylor, R.E. 1880-1896
Colonel John Pennycuick, R.E. 1896-1899
Colonel John Walter Ottley, R.E. 1899-1906

PROFESSORS OF CONSTRUCTION

Calcut Reilly 1871-1897
Colonel John Pennycuick, R.E. 1897-1899

PROFESSORS OF MATHEMATICS

The Rev. Joseph Wolstenholme, M.A. 1871-1884
Arnold Lodge, M.A. 1884-1904
Richard Haygarth, M.A. 1904-1906

PROFESSORS OF APPLIED MATHEMATICS

Alfred G. Greenhill, M.A. 1872-1875
E.J. Nanson, M.A. 1874-1875
George Minchin Minchin, M.A., F.R.S. 1875-1906

PROFESSORS OF ENGINEERING AND APPLIED MATHEMATICS


Assistants:
Archer H. Heath, M.I.C.E. 1875-1901

PROFESSORS OF HYDRAULICS AND MECHANICS

William Cauthorne Unwin, F.R.S. 1872-1884
Thomas Alfred Hearson, F.R.S. 1884-1901

Demonstrators:
Philip Reilly 1885-1901
Charles A. Carus Wilson 1887-1890

PROFESSORS OF PHYSICS AND ELECTRO-TECHNOLOGY

William Nelson Stocker 1883-1901
Alfred Hay, D.Sc., M.I.Elec.Engs. 1900-1904

Demonstrators:
W.G. Gregory 1883-1892
T. Shields 1892-1901
W.S. Templeton 1902-1906
A.F.T. Atchison 1902-1906
PROFESSORS OF CHEMISTRY

Herbert McLeod 1871-1901
Francis E. Matthews, Ph.D., F.I.C. 1885-1906

ANALYTICAL CHEMISTS

Arnold Philip 1889-1892
Frank William Harbord, Assoc. Royal Sch. of Mines, F.I.C. 1892-1906

LECTURER IN ORGANIC CHEMISTRY

Arthur Herbert Church, F.R.S. 1888-1900

LECTURERS IN GEOLOGY AND MINERALOGY

Peter Martin Duncan, F.R.S. 1872-1890
Harry C. Seeley, F.R.S. 1890-1905

PROFESSORS OF SURVEYING

Cpt. William Henry Edgcombe, R.E. 1871-1885

Instructors in Surveying:
Lt. Theodore John V. Prendergast, R.E. 1885-1887
Lt. James Stewart, R.E. 1887-1894
Richard John Woods, M.I.C.E. 1892-1906

T.E. Curry 1900-1902
P.L.A. Price 1900-1902
Cpt. N.F. MacKenzie 1902-1905
Lt. F. MacDonnel Browne 1902-1905

PROFESSOR OF GEOMETRICAL DRAWING

Lt. George Sydenham Clarke, R.E. 1871-1880

Instructor in Geometrical and Architectural Drawing:
Thomas Henry Eagles 1872-1892

Instructor in Geometrical Drawing, Estimating and Architecture:
Arthur Hicks 1892-1906

Instructors in Freehand Drawing:
Samuel T.C. Evans 1871-1883
Russel Dawson 1883-1897

PROFESSOR OF FORESTRY

William Schlich, C.I.E., Ph.D., F.R.S., F.L.S. 1885-1905

Assistant Professor of Forestry:
W.R. Fishel, B.A. 1898-1905
PROFESSORS OF BOTANY
H. Marshall Ward 1886-1896
Charles Alfred Barber 1896-1905

LECTURERS IN ENTOMOLOGY
Arthur Everett Shipley 1887-1889
Walter F.H. Blandford 1889-1898

LECTURER IN BOTANY AND ENTOMOLOGY
Percy Groom, D.Sc., M.A., F.L.S. 1898-1905

LECTURER IN FOREST LAW
Baden Henry Baden-Powell 1891-1896

LECTURERS IN ACCOUNTS
James C. Hurst 1885-1901
Robert G. MacDonald 1901-1902
Alfred R. Becher 1902-1905

LECTURER IN HINDUSTANI AND INDIAN HISTORY
Cotton Mather 1871-1881

Instructors in French:
F.W. Mariassy 1885-1889
Mons. J.A. Perret 1889-1906

Instructors in German:
T.H. Dittel 1885-1900
Dr. Aloys Weiss 1902-1905
APPENDIX C

Students of the R.I.E.C.
ABBET, C. C.  FCH  1890-1893

ADAM, James  FCH, AMICE  1882-1885

ADAM, John B. M.  FCH  1903-1906

ADAMI, George F.  1895-1898

ADAMSON, Arthur M.  1894-1897

ADOCK, Cecil P.  1899-1902

ADAMS-WILLIAMS, Christopher  CIE  1900-1903

ADDIS, Robert B.  FCH  1893-1896

AGNEW, Herbert C.  OBE  1898-1901

AHMED, Ali N. Y. J. B.  FCH  1896-1899

AHMEDAN, M.  1894-1897

AITKMAN, David L.  CIE (1912)  1882-1885

AITCHISON, Patrick E.  CIE (1934)  1900-1903

AITCHISON, William  1897-1900

AITKEN, C. H.  1879-1881

AKBAR, Ali  MICE  1879-1882

ALEXANDER, Edwin J.  FCH  1877-1880

ALLAN, Harvey A. R.  1898-1901

ALLCROFT, W. L.  1891-1893

ALLEN, B. F.  1888-1889

ALLEN, Parker R.  1879-1882

ALLEN, Walter G.  1888-1889

ALLEN-WILLIAMS (Formerly Williams) Sir Arthur J.  Extremely distinguished KBE, CMG, Legion d'Honneur etc...

ANDERSON, Archibald R.  1901-1902

ANDERSON, George A.  1872-1875

ANDERSON, Reginald d'Arcy  1898-1899

ANDERSON, T. C. B.  1893-1896

ANSTRUTHER, William T.  1876-1879

APPLEBY, Arthur S.  1898-1901

APPLEBY  1880-1881

ARBUTHNOT, Henry F.  1892-1895

ARMSTRONG, Herbert A.  1890-1892

MICE  1878-1881

FA, FCH  1871-1874

FCH  1895-1898

ASH, Herbert R. F.  1877-1880

ASHPITEL, Francis W.  AMICE  1879-1882

ASHTON, Harry F.  1890-1892

ASTHURY, Arthur R.  CSI, CIE, MICE  1897-1900

ATKINSON, Robert P.  AMICE  1873-1876

ATTFIELD, H. S.  1888-1891

AZZOPARDI, G.  1901-1902

BABINGTON, Chamberlain D. de Vitre  1893-1895

BABINGTON, Stephen  1890-1892

BACON, Henry M. J.  FCH  1880-1883

BAD, Barrister at Law, AMICE  1885-1888

BADHWAR, M. C.  1900-1903

BAGOT, W. E.  1886-1888
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<tr>
<th>Name</th>
<th>Title</th>
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<td>BAGSHAWE, Edward L.</td>
<td>CIE, DSO, OBE</td>
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BESTIC, William B. 1876-1879
BETTERTON, Frederick A. 1903-1906
BETTON, C. R. 1889-1891
BEWLEY, Alexander 1873-1876
BHATHENA, Rustom F. 1894-1897
BRORE, J. 1889-1892
BICKERTON, Charles H. C. 1897-1900
BIDDER, Maurice McLean DSO, MICE CIE, AMICE.
BIGSBY, Sydney H. CIE, AMICE.
BILLSON, Herbert G. CIE, FCH.
BIRD, William L. 1872-1875
BIRD, William J. A. 1875-1878
BISSET, Alexander A. 1902-1904
BLABER, Edward 1890-1893
BLACKER, B. H. 1877-1880
BALCKETT, John C. BA 1883-1886
BLACKLAW, Charles F. S. 1886-1887
BLANDY 1871-1873
BLANFORD, Harry R. CBE 1902-1905
BLOSCHEK, Arthur D. FCH 1897-1900
BLOOCH, Erlysmar 1896-1898
BLENKINSOP, Bernard A. 1899-1902
BLUNT, Arthur W. 1886-1888
BOALTH, Victor H. CBE 1891-1894
BOARD, Austin C. FCH 1902-1905
BOASE, James T. 1875-1878
BOND 1871-1874
BOND, Herbert I. 1897-1900
BOND, Wersly J. H. CB 1873-1875
BONHAM-CARTER, Lothian B. G. 1876-1879
BONHOTE 1880-1882
BORRAH, Boli N. 1877
BORROO, V. 1888-1891
BOSE, Lalit M. MICE 1886-1889
BOSTOCK, Thomas M. 1897-1900
BOVKE-BORROWES, Dermot R. S. 1902-1906
BOWDEN, Herbert J. A. 1877-1880
BOWER, P. H. FCH 1881-1884
BOYCE, Henry G. FCH, MICE. 1874-1877
BOYD, C. 1871-1872
BOYLE, Sir Alexander G. KCMG, CBE. 1890-1892
BOYLE, Arthur R. 1876-1879
BOYLE, John C. DL 1888-1891
BRANCKER, James D. D. DSO 1897-1900
BANFILL, B. 1890-1893
BOKKER, J. A. 1885-1888
BOWMAN, J. 1886-1889
BOWELL, Philip R. 1894-1897
BRANTWAITE, Francis J. 1886-1888
BRIGGS, Arthur B. 1902-1905
BRIGGS, Robert C. 1902-1905
BRODIE, William P. AMICE 1871-1872
BROKENSHAW, Arthur 1902-1906
BROOKE, George T. 1896-1899

...
BROOKE, James H.
BROOKS, Ricardo
BROWN, A.H.
BROWN, James S.
BROWN, Mortagne
BROWNLOW, F. A.
BRUCE, C. W. A.
BRUNET, J. R.
BRYANT, Horace B.
BUCK, R. D.
BUCKLEY, Ellerington W.
BUCKNILL, Walter B.
BUDHBBATTI, K. S.
BULL, Francis E.
BUNDOCK, A. F.
BURKE, Edmund P.
BURKE, Redmond St George
BURKITT, Francis H.
BURWELL, Charles H. B.
BURNE, W.
BURNE, Oldbury
BURN-MURDOCH, Alfred M.
BURROWS, E.
BURT, Sir Henry P.
BURTON, John D. M.
BURTON, John H. B.
BURTON, R.C.F.
BUSCARLET, Francis C.
BUTCHER, L. H.
BURLER, Hon. Robert T. R. P. M.
BUTLER, Theobald
BYRNE, John D.
BYRNES, William F.
CACCIA, Anthony M. F.
CAMERON, John G. P.
CAMERON, William L. S. L.
CAMPBELL, A.G.
CAMPBELL, A. W.
CAMPBELL, C. J.
CAMPBELL, William B.
CANNING, Frederick
CANTIN, Pierre A. L.
CAPE, George A. S.
CAPPEL, Stephen F. L.
CARLESS, George P.
CARLETON, H. D.
CARKE, F. W.
CARNegie, Hon. David W.
CARR, A. J. D.
CARR, Samuel
CARR, T.
CARROLL, John C.
CARSWELL, Eberezer A.
CARTER, Herbert
CARTER, Roderick E.

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CARTER, Thomas B. 1901-1904
CARTLAND, William N. 1904-1907
CARUS-WILSON, Charles A. M.A. (Cantab) 1879-1881
CASDAGLI, Alexander 1893-1896
CASEMENT, Roger H. 1901-1904
CATHER, G. F. H. 1885-1889
CATTON, John E. 1872-1874
CAVENDISH, France H. J.P. 1895-1898
CHADWICK, William FCH, AMICE 1875-1878
CHALART, Mon Chow 1904
CHAMBERS, C. 1881-1884
CHANCELLOR, A.J. 1871-1874
CHANNER, F. F. R. CIE 1893-1896
CHANTER, Francis W. 1874-1877
CHAPLIN, W. H. 1891-1893
CHAPMAN, A. E. 1882-1885
CHAPMAN, C. P. 1882-1883
CHAPMAN, J. A. 1896-1899
CHAPMAN, James B. 1892-1895
CHAPPEL, Herbert E. 1880-1883
CHATTERJEE, K. K. 1903-1906
CHEEKE, W. A. 1890-1891
CHIRNSIDE, J. B. 1878-1881
CHRISTIAN, Herschel D. 1901-1902
CHRISTIE, Harold Major OBE 1899-1902
CHRISTIE, H. R. S. Colonel RE, DSO, OBE. 1887-1890
CHRISTOPHER, H. C. 1872-1874
CLARK, Charles C. S. MICE 1879-1882
CLARKE, F. P. S. 1884-1887
CLARKE, Geoffrey AMICE 1901-1904
CLARKE, Harold O. 1893-1896
CLAUDET, Frederick B. 1876-1879
CLAYTON, Frank FCH, AMICE 1885-1888
CLAYTON, Robert O. 1876-1879
CLEAVER, Henry L. AMICE 1883-1886
CLEMENTSON, Edward H. 1873-1876
CLERK, Hugh E. CIE 1877-1880
CLIFFORD, James D. FCH 1901-1904
CLIFT, Frank C. L. 1903-1905
CLIFTON, Charles N. 1873-1876
CLOSE, Arthur M. 1900-1903
COBLECK, Charles E. Col. RE, MC, FCH. 1900-1903
CLOWES, Thomas H. 1880-1883
CLUTTERBUCK, Sir Peter H. Kt., CIE, CBE, VD. 1886-1889
COATES, John W. C. 1904-1906
COCHRANE, Alfred E. AMICE 1886-1889
COCKBURN, Edwin D. 1894-1897
COATES, Joseph OBE, BD, FCH 1890-1893
COLBOURNE, Rupert L.\ AMICE 1898-1901
COLE, Charles J. AMICE 1876-1879
COLE, William H. MICE 1873-1876
COLEBROOKE, Henry W. V. MICE 1871-1874
COLES, George E. 1871-1874
COLLET, James F. H. 1876-1879
COLLINGS, Arthur 1871-1874
COLLINGS, Francis W. 1900-1903
COLLINS, Frederick R. 1890-1893
COMBE 1883-1885
COMES, James A. 1875-1878
CONNELL, Cecil B. AMICE 1904-1907
CONNOR, George P. 1903-1906
COODE, C. L. 1888-1891
COODE, Francis T. 1894-1897
COODE, John M. 1883-1885
COODE, Mortgoner P. OBE, AMICE. 1873-1876
COOK, John P. 1896-1899
COOPER, H. dyster MC 1896-1898
COOPER, Harry dyster 1903-1906
COOPER, Lyall N. Col. RE, CBE, DSO. 1895-1898
COPELESTON, Waters E. CSI 1891-1894
CORBET, A. R. 1890-1893
CORBETT, Cecil Major R.A. 1897-1899
CORBETT, Patrick J. 1888-1891
CORBOULD, Pelham S. VD, JP. 1901-1904
COSINS, Richard G. 1894-1895
CORNELIUS, Eustace H. AMICE 1899-1902
COUCHMAN, Sir Francis D. KBE 1883-1886
COUPER, J. C. D. 1885-1887
COURT, R. F. 1899-1902
COURTHOPE, Edward A. 1886-1889
COTTTS, Ernest G. FCH 1891-1894
COVENTRY, Bernard O. FCH 1888-1890
COVENTRY, Edward M. 1887-1890
COWLEY, Francis A. A. CIE 1889-1891
COWLEY-BROWN, Francis L. C. 1892-1895
COUPER, Gerald 1891-1894
COX, Guthbert E. C. CIE 1899-1902
COX, Frederick N. OBE 1885-1888
COX, Spencer 1878-1881
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COXE, Richard K. 1884-1888
COT, Joseph P. 1876-1879
CRADDOCK, A. J. 1885-1889
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CRAVEN, Arthur J. Brigadier General RE, DSO. 1886-1889
CRAVEN, L. B. 1888-1891
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CRAWLEY-BOEVEY, Arthur C. BA, CO 1897-1900
CREEDY, H. D. 1894-1895
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CROFT, J. F. 1882-1884
CROOKES, L. P. 1893-1895
CROSLEGH, Lewis C. Major 1889-1892
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CUHITT, George E. S. CBE 1893-1896
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CURLING, Richard R. Lieut. Col. RA, DSO. 1903-1905
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HAINES, Henry H. CIE, FCH 1886-1888
HAINES, Reginald 1900-1902
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Kirkpatrick, Roger  1902-1905
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La-Touche, James N. D.  1877-1880
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