

Mass. Institute of Technology.

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PRESIDENT'S REPORT,

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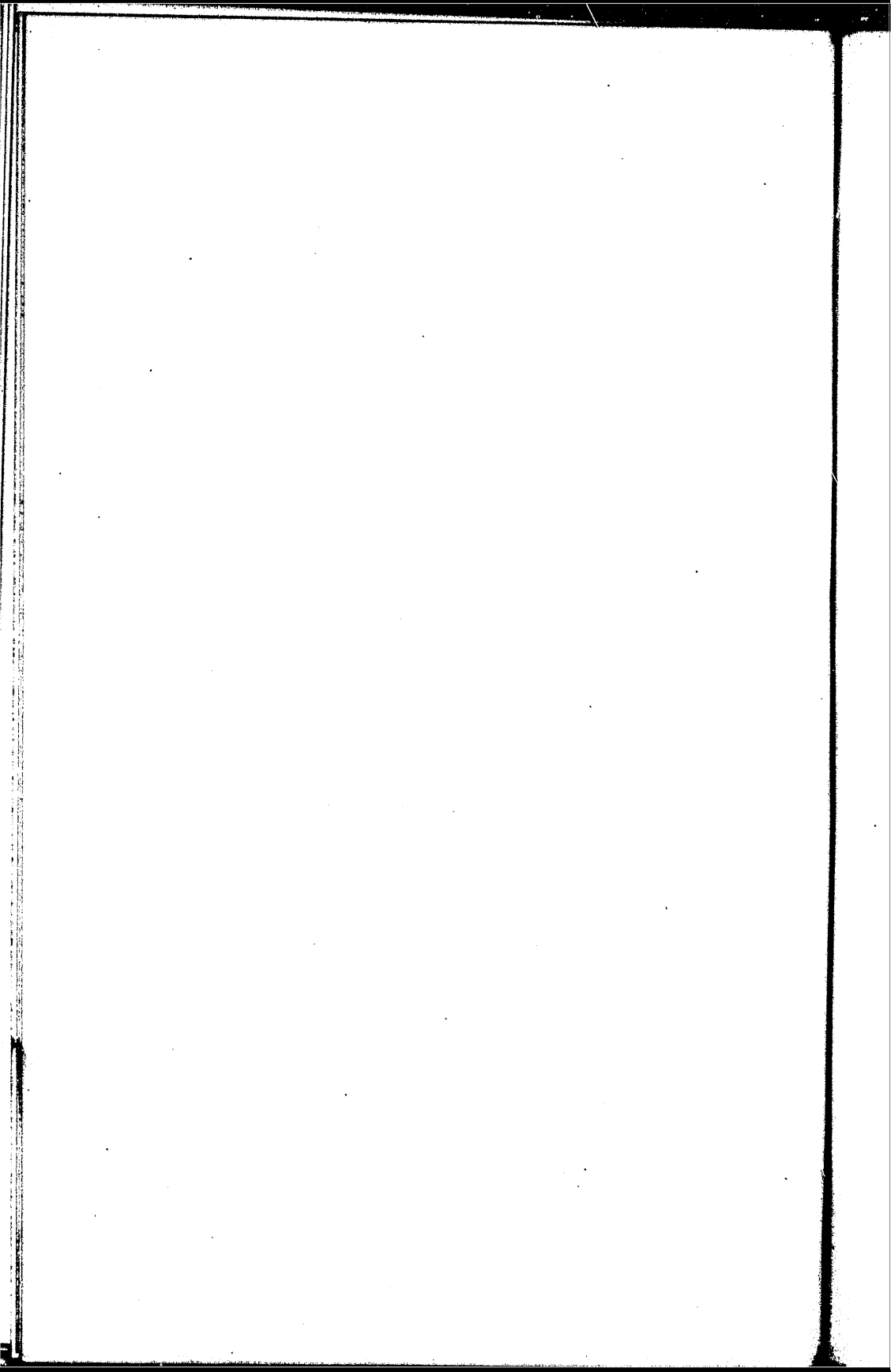
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To the Corporation of the Massachusetts Institute of Technology :

It is my pleasant duty to report to you the experiences of the Institute of Technology during the year, which has been, perhaps, the most fortunate and prosperous in our history, even among the many prosperous and fortunate years which we have, of late, enjoyed. The gains realized in the number of our students, and in our material means, have not been more remarkable than the improvement that has taken place in the variety and extent of the instruction given, in the quality of the classes coming to claim the benefits of that instruction, and in the general tone and spirit of the school. Never before has the Institute been in a position of equal usefulness ; never have its professors and instructors felt themselves so well repaid for all their exertions and sacrifices by the fruits of their labors, in the formation of character, in the growth of intellectual power, in the discipline of the faculties, and the acquisition of useful knowledge on the part of their students. With a full heart, I congratulate this Corporation, whose members have given to the interests of this School of Industrial Science such close attention and such generous support, together with the ripest fruits of their own large and varied experience of affairs, upon the high degree of success which has crowned their efforts.

THE GRADUATING CLASS.

The last school year closed fortunately. The class of 1888 graduated on the 29th of May. Of the 78 students of the fourth year, who were candidates for the degree of

Bachelor of Science, 77 were admitted to that grade by your authority, upon the recommendation of the Faculty. Never before has the proportion of applicants failing upon their final examinations and their thesis work been so small.

Not only was the class thus graduating the largest in our history, but in scholarship, in mental strength, and in manliness of character, it was a class which the Alumni of the Institute may be proud to add to their rolls. At the simple exercises of our graduation day, the class of 1888 were most happy in hearing words of counsel and cheer from the eloquent lips of Dr. Phillips Brooks, once a member of this Corporation.

THE NEW YEAR.

The opening of the academic year, 1888-89, witnessed an addition to the lists never but once equalled in our experience. The number of students in the School of Industrial Science, as by the Catalogue recently issued, is 827, against 720 reported last year, an increase of 107.

The following table exhibits the number of students in the School of Industrial Science each year, from the opening of the Institute to the present time:

Year.	No. of Students.	Year.	No. of Students.
1865-66	72	1877-78	194
1866-67	137	1878-79	188
1867-68	167	1879-80	203
1868-69	172	1880-81	253
1869-70	206	1881-82	302
1870-71	224	1882-83	368
1871-72	261	1883-84	443
1872-73	348	1884-85	579
1873-74	276	1885-86	609
1874-75	248	1886-87	637
1875-76	255	1887-88	720
1876-77	215	1888-89	827

I cannot forbear to repeat here the words I used in the same connection in my report of last year:—

“ Had the remarkable increase in the number of students since 1878 been secured by any lowering of the standard of scholarship, any surrender of the requirements for admission, for continuance in the school, or for graduation from it, that increase of numbers would not be to me a subject of pride or pleasure; but when I consider that this increase has taken place coincidently with a steady advance in scholarship; that these great bodies of students have come to us well knowing that the Institute is a place for hard study, and cheerfully accepting the conditions which we impose: this, I confess, appears to me a proper subject for congratulation. Not only so, but this readiness and eagerness on the part of so many young men to undertake severe and protracted courses of study, regarding which there can be no pleasing illusions, and which require the entire devotion of time and thought and strength for four years, affords a most gratifying indication of the essential manliness of young men.”

I do not see how the Corporation can fail to derive from this unprecedented resort of students to the halls of the Institute a strong assurance that there is something in the scheme of instruction which has been slowly built up here, during the past twenty-three years, especially in the close combination of theory with practice, so marked a characteristic of our system, which makes this school peculiarly useful to young men.

STUDENTS BY CLASSES.

The aggregate number of students for 1888-89 is divided among the several classes as follows:—

Graduate student, candidate for an advanced degree	1
Regular students, Fourth Year	74
“ “ Third Year	120
“ “ Second Year	144
“ “ First Year	251
Special students	237

Assigning the special students to classes according to the predominant studies pursued by them, we reach the

following statement of the division of the whole body among the several years :—

CLASS.	Regular.	Special.	Total.
Graduate of the M. I. T.	1	..	1
Fourth Year	74	28	102
Third Year	120	49	169
Second Year	144	81	225
First Year	251	79	330
	590	237	827

STATISTICS OF EXAMINATIONS.

The results of the applications for admission to all classes of the School of Industrial Science, thus far in the current school year, and of the examinations had thereupon, may be stated as follows :—

Eighty-seven were admitted without examination, either to the first-year class, upon presenting certificates of clear admission to some college of reputable standing, or, upon the presentation of diplomas of graduation from some degree-conferring institution, classical or scientific, to our second or third year class as regular students, or to some department as special students ; 189 were admitted upon examination, free of conditions ; 69 were admitted with one condition imposed, 30 with two conditions, 23 with three conditions, 16 with four conditions ; 62 applicants were rejected upon examination. The proportion of applicants receiving more than one condition, at the entrance examinations, is slightly greater than it was last year. This does not, however, as might be thought, represent a lower degree of preparation, on the part of the incoming class, but is due to the further division of the examinations heretofore given in what are called "English Studies." For-

merly two marks, only, were given on account of English, history, and literature. This year the Faculty, with a view to emphasize the importance of these subjects to students entering the Institute, and thus, so far as in them lay, to promote a more careful and extended preparation, on this side, in the "fitting schools" and academies, divided this group of subjects into three heads, giving a separate examination in each, and a distinct mark on each account. It was in this way that the number of conditions given was increased. On the other hand, the proportion of students admitted free of conditions in mathematical subjects was smaller than ever before.

The total number of applicants appears, therefore, to have been 476. Of those admitted upon examination, 52 have not thus far entered the school. In some instances, in the case of applicants heavily conditioned, this has been due to the advice of the Faculty that a longer period be taken for preparation; in some, to a change of plans, to sickness, or other causes.

EXAMINATIONS AT DISTANT POINTS.

In addition to the entrance examinations held in Boston in June and September, 1888, examinations were also conducted, in June, at Chicago, Cincinnati, Kansas City, Montreal, Nashville, New York, Philadelphia, Pittsburg, San Francisco, Santa Fé, St. Louis, St. Paul, and Washington.

STATISTICS OF RESIDENCE.

Thirty States of the Union, besides the Territories of Dakota, Wyoming, and New Mexico, and the District of Columbia, are represented in our lists of students. Canada, Greece, Ireland, Scotland, Peru, Brazil, Guatemala, Turkey, the West Indies, and the Hawaiian Islands have also sent us students.

Of the total number of 827, including special students, 494 are from Massachusetts, or 59.7 per cent of the whole; 105 are from other New England States; 211 from outside New England, of whom 17 are from foreign countries.

The following table shows the number of students of each specified class, from each State or foreign country:—

State.	Candidates for Advanced Degrees.						Candidates for Advanced Degrees.							
	Fourth Year.	Third Year.	Second Year.	First Year.	All Regular Students.	Special Students.	Total.	Fourth Year.	Third Year.	Second Year.	First Year.	All Regular Students.	Special Students.	Total.
Arkansas.....		1	1											
California.....	2	3	1	3	9	4	13							
Colorado.....		1	1	1	1	2	2							
Connecticut.....	3	9	11	23	5	28								
Dakota.....		1												
Dist. Columbia.....		2	4	6	3	9								
Georgia.....		1	1	1	1	1								
Illinois.....	2	7	7	12	28	9	37							
Indiana.....														
Iowa.....	2	1				3	6							
Kentucky.....		1				1	3							
Louisiana.....			2	2	2	1	3							
Maine.....	2	1	7	6	16	10	26							
Maryland.....	1	1	1	3	1	4								
Massachusetts.....	53	73	85	154	368	129	494							
Michigan.....	1	2	3	4	2	4	12							
Minnesota.....		1	1	1	1	1	4							
Missouri.....		1	1	1	1	1	4							
Nebraska.....		1	1	1	1	1	4							
N. Hampshire.....	3	3	3	3	17	7	24							
New Jersey.....	1	2					3							
New Mexico.....	2	4	11	4	21	10	31							
New York.....		1	1	1	1	1	5							
No. Carolina.....		1	6		15	8	23							
Ohio.....		1	1		1	1	4							
Oregon.....		1	1				2							
Pennsylvania.....	1	1	2	4	10	8	18							
Rhode Island.....	2	5	2	5	14	8	22							
Tennessee.....		1	1	2	1	1	3							
Texas.....														
Vermont.....		1		1	2	3	5							
Virginia.....		1	1	1	1	1	4							
Wisconsin.....		2	4	6	1	7								
Wyoming.....		1		1			2							
<i>Foreign Country.</i>														
Brazil.....				1	1	1	2							
Greece.....				1	1	1	3							
Guatemala.....				1	1	1	3							
Hawaiian Islds.....				1	1	1	3							
Ireland.....			1	1	1	1	4							
N. Brunswick.....			1	1	1	1	4							
Peru.....		1			1	1	3							
Porto Rico.....			1	1	2	1	5							
Prv. of Ontario.....		1			1	1	3							
“ “ Quebec.....					1	1	2							
Scotland.....				1	1	1	3							
Trinidad.....					1	1	2							
Turkey.....			1		1	1	3							
Total.....	74	120	144	251	590	237	827							

RESIDENCE OF MASSACHUSETTS STUDENTS.

It has been said that 59.7 per cent of all our students are from Massachusetts. All the counties of the State, except the small counties of Dukes and Nantucket, send students to the Institute of Technology. Ninety-four cities and towns are reported on the lists. The first column of

the following table shows the number of cities and towns in each county sending pupils to the Institute; the second column gives the aggregate number from each county. It appears that Suffolk furnishes us 183 pupils; Middlesex comes next, with 143; Essex third, with 45; Norfolk fourth, with 43:—

COUNTY.	No. of Towns.	No. of Students.	COUNTY.	No. of Towns.	No. of Students.
Barnstable . . .	2	4	Hampden . . .	4	6
Berkshire . . .	4	4	Middlesex . . .	27	143
Bristol . . .	4	25	Norfolk . . .	14	43
Essex . . .	14	45	Plymouth . . .	12	24
Franklin . . .	1	2	Suffolk . . .	2	183
Hampshire . . .	1	2	Worcester . . .	9	13
	26	82	Total . . .	94	494

The following is a list of the towns, twenty-eight in number, which send four or more scholars to the Institute:—

Boston 170	Taunton 8	Canton 4
Newton 32	Winchester 8	Framingham 4
Cambridge 22	Fall River 7	Gloucester 4
Chelsea 13	Malden 7	Hanover 4
Brookline 11	Melrose 7	Lynn 4
Lowell 11	Newburyport 6	Medford 4
Somerville 11	Hyde Park 5	Peabody 4
Salem 9	Stoughton 5	Watertown 4
Lawrence 8	Waltham 5	Weymouth 4
New Bedford 8		

PROPORTION OF OLD AND OF NEW STUDENTS.

The following table exhibits, for each year of the school's history, the distribution of the total number of students among two classes: first, those students whose names are

found upon the catalogue of the year preceding; and secondly, those students whose names appear as new names upon the catalogue of the year to which the statement relates:—

YEAR.	(1) Total No. of Students.	(2) No. of Students in the Cata- logue of the previous year who remain in the Institute.	(3) No. of New Students entering before issue of Catalogue.	(4) Of those in column (3) the following num- ber are reg- ular first-year Students.	(5) No. of New Students not of the regular first- year class.
1866-67	137	34	103	58	45
1867-68	167	79	88	54	34
1868-69	172	82	90	50	40
1869-70	206	90	116	63	53
1870-71	224	109	115	71	44
1871-72	261	122	139	82	57
1872-73	348	173	175	112	63
1873-74	276	171	105	59	46
1874-75	248	159	89	35	54
1875-76	255	139	116	65	51
1876-77	215	130	85	31	54
1877-78	194	96	98	47	51
1878-79	188	99	89	34	55
1879-80	203	102	101	34	67
1880-81	253	121	132	62	70
1881-82	302	136	166	86	80
1882-83	368	173	195	114	81
1883-84	443	231	212	140	72
1884-85	579	311	268	186	82
1885-86	609	369	240	177	63
1886-87	637	379	258	190	68
1887-88	720	396	324	229	95
1888-89	827	465	362	245*	117

It appears from the foregoing that the number of students remaining over has been increased by 69, while the number registered for the first time is larger by 38, making the net gain, as previously stated, 107.

The increase since 1886-87 of students not of the first-year class represents, in the main, students coming to us from other institutions, from which they have graduated,

* In addition, 6 students are repeating the first year.

or in which they have pursued their studies for one, two, or three years.

AGES OF STUDENTS ON ENTRANCE.

The next table exhibits the ages of our students upon entrance. The regular students of the first-year class number 251. From these we should except five cases of students of unusual ages: viz., three of 22, one of 25, and one of 26 years. These deductions leave 246 as the number of students whose ages have been made the subject of computation.

The results appear in the following table, in comparison with the corresponding results for 1887-88:—

PERIOD OF LIFE.	1887-88.		1888-89.	
	Half-Year Groups.	Yearly Groups.	Half-Year Groups.	Yearly Groups.
16 to 16½ years	3	..	3	..
16½ to 17 years	13	16	10	13
17 to 17½ years	34	..	23	..
17½ to 18 years	41	75	43	66
18 to 18½ years	42	..	53	..
18½ to 19 years	28	70	39	92
19 to 19½ years	30	..	25	..
19½ to 20 years	16	46	19	44
20 to 20½ years	12	..	16	..
20½ to 21 years	4	16	6	22
21 to 22 years	5	5	9	9
	228	228	246	246

From the foregoing tables it appears that the average age of the 246 students taken for this comparison, the present year, is 223.50 months, or 18 years, 7 months, and 15 days. This compares with the corresponding figures relating to the two previous entering classes as follows:—

	Av. Age in Months.
Class of 1889	218.53
Class of 1890	219.91
Class of 1891	221.55
Class of 1892	223.50

The progressive enhancement of the age of students, upon entrance, is partly due to general causes operating to bring students to colleges or to scientific schools at a later age; partly to the effect of a rule adopted by the Faculty of the Institute of Technology, three years ago, fixing the minimum for admission, except in extreme cases, at 17 years. To this rule, as stated, exceptions are allowed, especially between the age of 16½ and 17, in regard to students more than usually well prepared, or where good reasons exist for deeming it unwise to hold the applicant back for another year. But, in general, the rule is enforced with excellent effect. Even if the time of entrance should be still further protracted, our students would, nevertheless, graduate at an age youthful enough for the beginning of professional life and practice.

In this connection it may be interesting to note the ages at graduation of the class leaving us in May. The 77 members of the class were distributed among the several periods of life, as follows:—

Under 20	4	Between 22 and 23	23
Between 20 and 20½	6	“ 23 and 24	5
“ 20½ and 21	6	“ 24 and over	12
“ 21 and 21½	8		77
“ 21½ and 22	13		

PROPORTION OF REGULAR AND OF SPECIAL STUDENTS.

The following table exhibits both the absolute number of regular and of special students, as by the catalogue of each successive year, and the proportion existing between these two classes:—

2) 221.55
18.46

19.91
18.77

YEAR.	No. of Regular Students.	No. of Special Students.	Total No. of Students.	PERCENTAGE.	
				Regular.	Special.
				Per cent.	Per cent.
1865-66	64	8	72	89	11
1866-67	110	27	137	80	20
1867-68	124	43	167	74	26
1868-69	105	67	172	61	39
1869-70	125	81	206	71	29
1870-71	143	81	224	64	36
1871-72	180	81	261	69	31
1872-73	235	113	348	68	32
1873-74	182	94	276	66	34
1874-75	170	78	248	69	31
1875-76	182	73	255	71	29
1876-77	134	81	215	62	38
1877-78	117	77	194	60	40
1878-79	103	85	188	55	45
1879-80	110	93	203	54	46
1880-81	140	113	253	55	45
1881-82	164	138	302	54	46
1882-83	219	149	368	60	40
1883-84	272	171	443	61	39
1884-85	368	211	579	64	36
1885-86	415	194	609	68	32
1886-87	442	195	637	69	31
1887-88	520	200	720	72	28
1888-89	590	237	827	71	29

It will be noted that there has been a slight increase in the proportion of special students since my last report, the per cent having risen from 28 to 29. That is, six more students appear this year as "specials" than would have maintained the proportion existing in 1887. It is likely that the entire effect in this direction may have been caused by the earlier date of sending the list of students for the annual Catalogue to the printer this year, some students not having, at that date, arranged their courses in such a way as to become "regulars." But of far greater influence in increasing the list of special students, this year, has been the remarkable addition made to the department of Architecture, the number of students in this course hav-

ing increased fifty per cent. But for this, the proportion of special to regular students in the school, as a whole, would have fallen to 25 per cent, or lower.

WOMEN AS STUDENTS IN THE INSTITUTE.

The number of women pursuing courses with us last year was 25; this year it is 33, of whom 5 are graduates of colleges. Of the total number, 2 are regular students of the third year; 2 of the second year; 3 of the first year; 26 are special students. Of the 4 regular students of the upper classes, 1 takes Course IV., architecture; 1 Course V., chemistry; 1 Course VII., natural history; 1 Course IX., the general course. Of the special students, 15 devote themselves chiefly to chemistry and physics; 9 chiefly to biology and allied subjects; 1 to mathematics; and 1 to architecture.

GRADUATES OF OTHER COLLEGES.

Thirty-four graduates of institutions conferring degrees are included in our list of students for the present year. Of these, 1 is our own graduate, pursuing advanced studies as a candidate for the degree of Doctor of Philosophy. Thirty-three are graduates of other institutions, either scientific or classical, pursuing courses of study with us, either as regular students, candidates for our Bachelor's degree, or as special students. Of these, 9 are graduates of Harvard University, 4 of Brown University, 3 of Yale University, 2 each of Vassar College and Georgetown College, while 1 comes from each of the following institutions: Oxford University, University of Minnesota, University of the Pacific, Iowa State University, Oregon State University, Union College, Oberlin College, Wellesley College, Smith College, Hobart College, Haverford College, St. John's College, and St. Mary's College.

Of the 33, 1 is a regular student of the fourth year in civil engineering; 9 are regular students in the third year, — 3 in mechanical engineering, and 2 each in civil engineering, architecture, and electrical engineering; 2 are regular students in civil engineering, and 2 in electrical engineering, in the second year; 1 is a regular student in the first year. The remaining 18 are special students.

THE COURSES OF INSTRUCTION.

The following table presents the number of students in each of the regular courses. It will be seen that this statement relates to the second, third, and fourth years, choice of courses being made only at the end of the first year:—

YEAR.	Civil Engineering.	Mechanical Engineering	Mining Engineering and Metallurgy.	Architecture.	Chemistry.	Electrical Engineering.	Natural History.	Physics.	General Course.	Chemical Engineering.	Total.
4th Year Class . . .	17	22	3	3	7	18	..	2	2	..	74
3d " " . . .	28	36	5	8	9	22	2	2	8	..	120
2d " " . . .	26	42	4	10	12	34	2	1	2	11	144
Total	71	100	12	21	28	74	4	5	12	11	338

The distribution of the students of the fourth year among the different branches of those courses in which there are distinct lines of choice, is as follows:—

Of the 17 students in Course I., 14 follow the traditional line of civil engineering, while 2 have taken railroad engineering and 1 the option in geodesy and geology.

Of the 22 students in mechanical engineering, 4 are taking the marine engineering option, 5 the locomotive engineering option, and 13 the mill engineering option.

The 3 students in Course III. all pursue the metallurgical option.

Of the 7 students in Course V., three make a specialty of industrial chemistry, and four of organic chemistry.

The following table exhibits the number of persons who have graduated within each of the several courses, at each succeeding year since the first diplomas were conferred:—

YEAR.	Civil Engineering.	Mechanical Engineering.	Mining Engineering.	Architecture.	Chemistry.	Metallurgy.	Electrical Engineering.	Natural History.	Physics.	General Courses.	Total.
1868	6	1	6	..	..	..	..	..	..	1	14
1869	2	2	..	..	1	..	..	..	..	..	5
1870	4	2	2	..	1	..	..	..	..	1	10
1871	8	2	5	..	2	..	..	..	..	..	17
1872	3	1	5	..	3	..	..	..	..	..	12
1873	12	2	3	1	7	..	..	..	..	1	26
1874	10	4	1	1	..	..	..	..	..	2	18
1875	10	6	6	1	1	..	..	..	1	2	27
1876	12	9	7	..	5	1	..	2	3	4	43
1877	12	6	8	4	2	..	..	..	..	..	32
1878	8	2	2	3	3	..	..	..	..	1	19
1879	6	8	3	1	3	..	..	1	1	..	23
1880	3	..	3	..	1	..	..	..	..	1	8
1881	3	5	6	3	8	..	..	1	..	2	28
1882	2	5	5	3	6	..	..	1	1	1	24
1883	3	7	4	1	3	..	..	..	..	..	18
1884	5	6	13	..	12	..	..	..	..	..	36
1885	4	6	8	2	4	..	2	..	..	1	27
1886	9	23	7	1	7	..	10	1	..	1	59
1887	10	17	8	1	9	..	8	1	1	3	58
1888	11	25	4	5	10	..	17	3	1	1	77
Total	143	139	106	27	88	1	37	10	8	22	581
Deduct names counted twice											2
											579

THE WORK OF SPECIAL STUDENTS.

The 237 special students in the School of Industrial Science cannot be classified systematically; but the follow-

ing table exhibits the number of special students pursuing each particular branch of study :—

NUMBER OF SPECIAL STUDENTS ATTENDING EXERCISES IN THE FOLLOWING DEPARTMENTS OF STUDY OR PRACTICE.

Architecture	72	Geology, etc.	44
Applied Mechanics	28	German	75
Astronomy	13	Mathematics	92
Chemistry	79	Mechanical Engineering	53
Civil Engineering	21	Mining and Metallurgy	21
Mechanical Drawing	25	Physics	86
Descriptive Geometry	48	Political Science	54
English	45	Shopwork	55
French	29	Heating and Ventilation	4
Total number of entries, by special students		844	
Total number of special students		237	
Average number of entries		3.6	

The average number of entries this year is precisely the same as last year.

It may be of interest to note the numbers of students, either regular or special, pursuing certain leading branches of study, in each of the four years, which are as follows :—

STUDIES.	First Year.	Second Year.	Third Year.	Fourth Year.	Total.
Mathematics	282	190	106	73	651
Chemistry	298	39	36	18	391
English	269	170	85	7	531
French	241	27	10	..	278
Physics . . . . .	..	200	141	32	373
German	43	157	139	4	343
Shopwork . . . . .	..	118	43	33	194

THE CORPS OF INSTRUCTORS.

A still further increase of the instructing staff has been required during the year.

The Catalogue for 1888-89 shows the number of instructors of all grades, excluding those persons who are announced as lecturers for the year only, to be 79, against 75 last year.

The following table shows the number of teachers of each recognized grade, exclusive of the department of Mechanic Arts, in each year since the foundation of the school:—

YEAR.	Professors.	Associate Professors.	Assistant Professors.	Instructors .	Assistants.	Total.
1865-66	10	..	..	..	..	10
1866-67	12	..	..	2	..	14
1867-68	12	..	1	2	2	17
1868-69	13	..	..	6	1	20
1869-70	16	..	1	6	2	25
1870-71	18	..	2	7	5	32
1871-72	21	..	2	11	1	35
1872-73	23	..	2	9	1	35
1873-74	20	..	3	10	4	37
1874-75	20	..	3	7	3	33
1875-76	23	..	..	6	8	37
1876-77	21	..	..	4	10	35
1877-78	20	..	..	3	14	37
1878-79	18	..	..	7	12	37
1879-80	16	..	..	7	8	31
1880-81	15	..	2	6	7	30
1881-82	17	..	3	6	11	37
1882-83	16	..	3	10	11	40
1883-84	15	..	8	15	10	48
1884-85	14	3	11	15	14	57
1885-86	14	6	7	17	18	62
1886-87	12	7	6	27	17	69
1887-88	13	6	9	30	17	75
1888-89	12*	7	10	32	18	79

CHANGES IN THE FACULTY AND THE CORPS OF INSTRUCTORS.

The Faculty and the school have suffered a great and painful loss, since the present academic year began, by the

* Since the Catalogue was sent to press has occurred the death of Prof. Otis, which will be referred to in a later part of this report. The tables relating to instructors are made up from the facts of the Catalogue.

death of Prof. Charles P. Otis, who has, for sixteen years, been at the head of the department of Modern Languages in this institution. Prof. Otis's health gave way, in a most critical manner, toward the close of the last school year; and his place in the work of instruction was immediately supplied, in order that he might have the fullest opportunity for rest and recovery. During the summer, hope was entertained by himself and his friends that he would be able to resume his duties the present year; but, as the season approached, it became painfully evident that his restoration to full working strength was not to take place so soon, if ever. The Executive Committee of the Corporation promptly granted him a leave of absence for the year, which he accepted with the purpose of seeking health in Germany. Early in November, however, a critical change for the worse appeared, and he rapidly declined until his death, on the 17th of that month. The cause of his untimely decease was an obscure cerebral affection, which, though unsuspected, had probably been long coming on.

Prof. Otis was born in Lebanon, Conn., in 1840; prepared for college at Phillips Academy, Exeter, N. H.; and, entering Yale College in 1857, graduated with high rank in 1861. For four years after his graduation, he taught school in Fairfield and in New Haven, Conn., and was then, for an equal period, a tutor in Yale College. He went abroad in 1869, for three years of study in Paris and Berlin. On his return he became a pupil of Whitney, in New Haven, receiving the degree of Ph. D. from Yale College in 1873. In the same year he became Professor of Modern Languages in the Institute of Technology.

Prof. Otis was a ripe scholar, a laborious student, a painstaking teacher, a scrupulously faithful and diligent member of the Faculty of the Institute. His sterling sense of justice, his quiet enthusiasm, and uniform kindness attached his students strongly to him; and of the many classes which have graduated from the Institute

since he took the chair of Modern Languages there are few members who do not owe to him much of their preparation, in mind and character, for the duties of life. Prof. Otis had published a text-book of "Elementary German," widely used among the colleges of the country, and had edited, to the great satisfaction of the scholarly world, several important German texts. He had also printed, but not published, an outline of Middle High German Grammar and selections from the *Nibelungen Lied*.

During the past year, the Executive Committee reached the conclusion, to which various considerations had seemed for some time to point, that, in the growth of the Institute and the increase of the instructing staff, it had become desirable that the classes in Zoölogy and Palæontology should be taught within the lecture-rooms and laboratories of the Institute itself. In accordance with this view, so much of the arrangement between the Institute of Technology and the Boston Society of Natural History as provided for the instruction of our classes by the Custodian of the latter society, was, after due notice, terminated; and the instruction in those subjects was charged upon Prof. Sedgwick and Dr. Gardiner.

In thus terminating an arrangement which had existed, with mutual advantage to both institutions, through a long term of years, the Faculty and the Corporation were not insensible of the extraordinary merits of Prof. Hyatt, Custodian of the Boston Society of Natural History, whether in scientific discovery or in the popular exposition of natural laws. The action recited was taken under the conviction that the time had come, in the development of the Institute, when the instruction given in the several departments of natural history should be more closely coordinated than had previously been possible, and that the students of these departments should receive all their regular or ordinary instruction within the walls of the Institute.

Another important change within the Faculty during the past year has resulted from a somewhat similar cause. It has for some time seemed desirable that the large and growing department of Architecture should have for its head a gentleman not engaged in professional practice, whose time and thought would, therefore, be given wholly and without interruption to the building up of the department, and who would be able to closely follow the course of his pupils and study their individual needs. However desirable this has seemed in the past, it has not been deemed practicable. In the provision for the present year, however, it was found possible to secure the advantages anticipated from such a course; and, in a very cordial appreciation of the best interests of the school, Prof. Theodore M. Clark, who has for seven years occupied the chair of Architecture, vacated his office to allow such an arrangement to be effected. Mr. Clark carries with him the thorough respect and warm regard of all his late associates.

The chair of Architecture has been filled by the appointment of Mr. Francis W. Chandler of this city. Mr. Chandler entered the office of Messrs. Ware & Van Brunt, as a student, in 1864. After remaining there three years he entered the *Atelier Daumet*, in Paris.

In 1869-70, Mr. Chandler was connected with the Institute of Technology as Prof. Ware's assistant in the department of Architecture. In 1871, he became assistant supervising architect of the Treasury Department, at Washington, and in that capacity took part in framing the plans of many important Government buildings. In 1874, he became associated with Mr. Edward C. Cabot, in the architectural firm of Cabot & Chandler. On accepting his appointment as Professor of Architecture, Mr. Chandler retired from practice, in order to devote his entire time and thought to the needs of the department.

Asst. Prof. Schwamb has, in recognition at once of his high professional acquirements and of his arduous labors

in the department of Mechanical Engineering and as director of the workshops, been appointed Associate Professor of Mechanism.

Dr. Davis R. Dewey, whose appointment as Instructor in History and Political Science was noted in my report of 1886, has, during the year, been promoted to be Assistant Professor of Economics and Statistics, the work in history which formerly devolved upon Dr. Dewey, together with additional duties arising from our growth in numbers, and from the increased attention given to this class of studies, having been assigned to a new member of the Faculty, Dr. Charles H. Levermore.

Dr. Levermore entered Yale College in 1875, graduating with honors in 1879. For the four years next succeeding, he was principal of the Academy at Guilford, Conn. In 1883, he entered upon a course of graduate study, in the department of history and political science, in the Johns Hopkins University, devoting a portion of his time to pedagogics and philosophy. In 1884-85, he held a fellowship in that university. In 1885-86, Mr. Levermore held the position of instructor in the Hopkins Grammar School, in New Haven, Conn. In 1886, he received the degree of Doctor of Philosophy from the Johns Hopkins University, and soon after accepted an appointment as instructor of history in the University of California. This position he resigned, on the 1st of February, 1888, to accept an appointment as Assistant Professor of History in this institution.

In addition to minor contributions to the press, Dr. Levermore has published the following results of his studies:—

First. A History of Witchcraft in Connecticut, published in the *New Englander*, in November, 1885.

Second. An Account of the Town and City Government of New Haven, a portion of his thesis for the Doctor's degree, published in the Fourth Series of J. H. U. Studies in History and Political Science.

Third. The Republic of New Haven : A History of Municipal Evolution, constituting Vol. I. of the Special Series of J. H. U. Studies in History and Political Science, 1886.

Fourth. Two chapters, on Municipal Government, in Atwater's History of New Haven, 1887.

At the middle of the last school year Mr. Arthur N. Wheelock, who had served with acceptance for two years as Instructor in English, was obliged, on account of impaired health, to relinquish his charge. Mr. Wheelock's work thus suddenly devolved upon Mr. F. B. Emery, his assistant. These onerous and responsible duties were taken up and carried on by Mr. Emery, in addition to his own proper work, with so much intelligence, spirit, and ambition as to cause his appointment, the present year, as Instructor.

On the failure of Prof. Otis's health, in March last, the Executive Committee requested Mr. W. C. Dreher to assume temporary charge of his classes in German. This was done to the entire satisfaction of the Faculty, and Mr. Dreher was appointed an Instructor for the present school year.

Mr. Dreher graduated from Roanoke College in 1878. After graduating, he taught for four years, and pursued a two years' course in theology at Yale College. He then became the Principal of the Preparatory Department of Roanoke College, occupying this position for a year, at the conclusion of which he went abroad for two years' study in France and Germany.

Mr. Eugene H. Babbitt, who was, during the last school year, an Instructor in Modern Languages at the Institute, and who had proved himself an exceedingly capable and accomplished teacher, resigned the position at the close of the last year, much to our regret, to accept a position in Harvard University. Mr. Frank Vogel, a graduate of Harvard University in the class of '87, was appointed to fill the vacancy thus occasioned.

Dr. Howard V. Frost, after two years' absence, returned to the Institute, at the opening of the school year, from Germany, where he had taken his Doctor's degree; and resumed the charge of the laboratory of General Chemistry. Mr. Frederic L. Bardwell, who, during Mr. Frost's absence, conducted the work of this laboratory to the entire satisfaction of the Faculty, remains as Dr. Frost's assistant.

Mr. Harry W. Tyler, Instructor in Mathematics, who was last year absent on leave, further pursuing his mathematical studies in Germany, still remains away. He is expected to resume his duties at the Institute at the beginning of the next school year.

Three others of the Instructors or Assistants of last year, namely, Mr. Henry P. Talbot, Instructor in Chemical Analysis, Mr. Arthur A. Noyes, Assistant in General Chemistry, and Mr. Frederick Fox, Jr., Assistant in Sanitary Chemistry, left the Institute at the close of the school year 1887-88, in order further to pursue their studies abroad.

After four years' valued service, first as Assistant and then as Instructor, in the Laboratory of Industrial Chemistry, Mr. George R. Underwood resigned, at the close of the last year, to enter into professional practice.

The following named gentlemen, graduates of the class of '86, and Assistants in their respective departments during the previous two years, have this year been appointed to the grade of Instructor:—

Mr. Dana P. Bartlett, in Mathematics; Mr. Harry E. H. Clifford, in Physics; Mr. Edward F. Miller, in Mechanical Engineering; Mr. Arthur G. Robbins, in Civil Engineering.

Mr. Dwight H. Perkins having declined reappointment as Junior Instructor in Architecture, Mr. Frank A. Moore, of the class of '88, has been appointed to that position.

The Assistants for the school year 1888-89 are as fol-

lows : Edward S. Foss, Louis E. Levi, and Edward C. Holton, in General Chemistry ; Alfred J. Wakeman, Jas. W. Loveland, and Chas. Ferry, in Chemical Analysis ; Arthur J. Conner, in Industrial Chemistry ; Geo. L. Heath, in Sanitary Chemistry ; Ralph E. Curtis, Wm. O. Hildreth, B. R. T. Collins, and Geo. W. Hamblet, in Mechanical Engineering ; Jas. H. Stanwood, in Civil Engineering ; Chas. F. Hastings, in Mining and Metallurgy ; Fred. B. Cole, in Drawing ; Edward Collins, Jr., in Physics ; Amos E. Woodward, in Geology ; and Arthur B. Frizell, in Mathematics.

In addition to the regular staff of instruction, the following gentlemen have been appointed lecturers for the current year : George W. Blodgett, S. B., on Applications of Electricity to Railway Working ; Henry M. Howe, A. M., S. B., on Metallurgy ; C. Howard Walker, on History of Ornament ; Ross Turner, on Water Color and Sketching ; Charles W. Hinman, S. B., on the Manufacture of Illuminating Gas ; Walter S. Allen, S. B., on the Manufacture of Fertilizers ; Eliot Holbrook, S. B., on Railroad Maintenance ; David A. Gregg, on Pen and Ink Sketching ; Anthony C. White, S. B., on the Distribution of Electricity for Commercial Purposes ; Edward Blake, Ph. B., on the Construction and Applications of Electro-Motors

The following table exhibits the number of Instructors of all classes, including the lecturers appointed for the current year, assistants performing the duties of instructors, assistants in drawing rooms and laboratories, and also instructors and assistants in the mechanic arts :—

	Civil Engineering.	Mechanical Eng. and App. Mechanics.	Mining Engineering, and Metallurgy.	Architecture.	Chemistry.	Physics and Elect. Engineering.	Biology, Zoology, etc.	Mineralogy, Geology, and Geography.	English and Political Science.	Language.	Mathematics.	Drawing and Descrip. Geometry.	Mechanic Arts.	Military Tactics.
Professors.....(12)	1	1	1	1	1	1	1	2	1	2	.....	.....	.....	.....
Associate Professors,(7)	.....	1	.....	1	1	1	1	.....	.....	1	1	.....	.....	.....
Assistant Professors,(10)	3	1	1	.....	1	.....	.....	1	2	.....	.....	1	.....	.....
Instructors.....(36)	1	5	.....	2	6	4	1	1	1	3	4	3	4	1
Assistants.....(21)	1	4	1	.....	8	1	.....	1	.....	.....	1	1	3	.....
Total.....(86)	6	12	3	4	17	7	2	4	5	5	8	5	7	1
Lecturers.....(10)	1	.....	1	3	2	3	.....	.....	.....	.....	.....	.....	.....	.....
Total.....(96)	7	12	4	7	19	10	2	4	5	5	8	5	7	1

On account of the increase in the number of students in the laboratory of industrial chemistry, and, also, with a view to carrying further than had been possible before the instruction given in bleaching, dyeing, and coloring, Mr. John W. Smith, for several years superintendent of the Walpole Dye Works, was appointed, at the close of the last year, Instructor in Textile Coloring.

THE LOWELL SCHOOL OF INDUSTRIAL DESIGN.

No change of importance has occurred in the Lowell School of Industrial Design since my last report. The school continues its most useful work in fitting young men and young women for positions as designers, especially in connection with the textile industries, but also in many other branches of manufacture in which taste in form and color is an essential element of success. The number of students, heretofore fixed at sixty-two, has this year been, in conference between Mr. Augustus Lowell, trustee of

the Lowell Institute, and the president of the Institute of Technology, reduced to fifty-three, in order to give ampler accommodations to the students, and to allow to each a larger share of the personal attention of the instructors concerned. The exhibition of the work of the students made in May last, in connection with the graduating exercises of the Institute, I think surprised even those who had most carefully followed the development of the school, by the beauty, variety, and originality of the designs shown.

THE SCHOOL OF MECHANIC ARTS.

Very important action has been taken by the Faculty and the Corporation, during the past year, regarding the School of Mechanic Arts, which was first established in the Institute of Technology in the year 1876, under the presidency of Dr. Runkle. The object in view, in the original establishment of this school, was twofold: —

First. It was considered a means of providing for the mechanical engineering students of the School of Industrial Science workshops, machinery, and tools, which the means of the Institute did not, at that time, allow the Corporation otherwise to provide.

Secondly. To set an example of scientific instruction in the mechanic arts, in connection with ordinary high-school instruction in letters, language, and mathematics, which might be of service to the community and to the country, by promoting the general introduction of schools of this class, maintained either by private benevolence or by public grants.

The first object of the Corporation in establishing the School of Mechanic Arts was fully attained. The school, from the beginning, paid its expenses, and, moreover, furnished workshops and tools in which the then limited number of students of mechanical engineering could ob-

tain this much-needed instruction without cost to the general funds of the Institute.

Regarded as a public-spirited effort to promote a new and much-needed kind of education, the School of Mechanic Arts has justified its existence. All the schools, in this region and at the West, in which ordinary high-school instruction in letters, language, and mathematics is combined with instruction and practice in the mechanic arts, may fairly be said to be offshoots of the school established here in 1876. Some of these schools are already doing a great public service for their respective communities ; and I entertain the confident expectation that the number and influence of such schools will be rapidly multiplied.

But while, thus, our School of Mechanic Arts had fully justified its establishment, from every point of view, it has for several years been evident, either that much should be done and large expenditures made, by the Corporation, for the purpose of building up this subsidiary school, or else that it should be abandoned. It is always a matter of serious question whether a preparatory school can be advantageously connected with an institution of higher learning. Experience shows that there is great danger that the preparatory school will draw away much of the vitality of the higher institution without itself being adequately benefited. In our own case, the reasons which ordinarily exist for the separation of the preparatory school, were made doubly strong by the rapid growth of the School of Industrial Science, which called for all the time and means which the Faculty and Corporation had to bestow. For two or three years, efforts have been made to secure an independent equipment and endowment for the School of Mechanic Arts ; but, as these efforts proved fruitless, there seemed to be no resource but to discontinue the school. This was accordingly done by the Corporation at its May meeting, as recited ; and at the same time the subject of the establishment of a high school of the mechanic art.

for the youth of Boston was commended to the favorable consideration of the school committee of the city.

The instruction given in the mechanic arts to the students of the School of Industrial Science will in no way be affected by this action. On the contrary, the discontinuance of the subsidiary school will afford ampler accommodations and allow a freer use of the machinery and tools on the part of the engineering students.

CHANGES IN COURSES OF STUDY AND IN LABORATORY ACCOMMODATIONS.

The changes which have taken place in the established courses of study in the Institute of Technology during the past year have, in the main, been in the way of small progressive improvements or enlargements, shown by experience to be both practicable and desirable, and taking place almost insensibly.

Summer Schools. — In my last report, I stated that the Faculty, with a view to supplying a long-felt want, had made provision for a summer course in topography, geodesy, and geology, extending through the early part of the vacation following the close of the third year, in Course I. The plan thus announced was successfully carried out during the summer of 1887, at South Deerfield, Mass. The school covered a period of four weeks, of which three were devoted to topographical work, with the stadia and plane-table, base-line measurement, triangulation, hypsometric work, and a study of the geology of the region; while the remaining week was occupied in gauging the flow of the Connecticut River by various methods. The instructors in attendance were Profs. Swain and Niles, and Asst. Profs. Burton and Porter, all of whom gave their services gratuitously. Prof. Burton had immediate charge of the school during the first three weeks, while the hydraulic

work was carried out by Prof. Swain. Eight students were in attendance, all of them members of the present graduating class. They manifested, throughout, the greatest interest in the work; the health of all the members of the party was exceptionally good; and a great deal was accomplished. The object of the school, as stated in the last report, was not to complete any given piece of work, but to instruct the students in directions which cannot be sufficiently followed out in the course of the regular school year; and in doing this it was in every sense successful.

The school will be again carried on during the coming summer, at some locality not yet decided upon. The work will not be essentially different from that of last summer, except that more of purely geodetic and astronomical work will be introduced.

In addition to the summer school of topography, geodesy, and geology, for the benefit of the civil engineering department, there was instituted a corresponding course, which had been for several years in contemplation, for the students of the mining and metallurgical department. In eleven out of sixteen years, beginning with 1872, the students of this course have devoted a portion of the long vacation to excursions, sometimes extensive in their range, in the course of which important mining districts were visited, and mines and their works were inspected by the students, and made the subject of informal lectures by the instructors in charge. In one year or another, during this period, excursions of such a character have been made to Colorado, to the Lake Superior district, to Virginia, Vermont, Pennsylvania, the Lake Champlain district, New Brunswick, and Nova Scotia.

In anticipation of the summer of 1888, however, it was deemed desirable to make a departure from the method heretofore pursued; and it was determined that the summer school of mines should be held in some appropriate locality for a term of six weeks; and that the students

should be given an opportunity not only to witness mining work in progress, but themselves to take part in the various operations. The locality chosen was the Eustis mine, at Capelton, Canada; and the time taken, the month of June and the first half of July. The number of students in attendance was fifteen, who were divided into squads, which worked, alternately, one week in the mine and one week above ground. The work in the mine consisted in making a survey, as complete as possible, of the whole mine, and in determining the location of several vertical shafts, at the surface, which should strike the vein from 600 to 1,500 feet lower down upon the slope than the present workings. Profiles of the several shafts were run to show their irregularities, and to indicate the amount of work which would be required to straighten them. The students all took a four days' turn at drilling and blasting; and in this, as in many other ways, they quite won the hearts of the miners by the readiness with which they acquired both the skill and the judgment required for economical mining. They also took a turn at setting timbers and laying track.

The work on the surface consisted in examining and reporting upon the methods of sorting and shipping the ore, and in making assays of some of the products; also, in carrying on a geological survey of the locality, which brought out some new features of the structure of the mountain that had not before come to light, and that proved of considerable interest, in connection with the deposit of valuable mineral.

As there were no boarding-houses in the vicinity, the students camped out in tents brought with them from Boston. The camp proved a very comfortable one; and uniform good health was maintained. The cost of subsistence was \$1.00 per day per scholar, not including fares to and from Boston. Both Prof. Richards and Asst. Prof. Clark were in attendance upon this school throughout its entire course.

The instructors who had charge of the summer school of mines are enthusiastic as to the practical results immediately attained, and still more so as to the influence of such a term of experimental work upon the subsequent career of the students engaged. They have already found, during the course of the present school year, that the students who have had this experience occupy a different mental attitude, when in attendance on the mining lectures, from those who did not share that experience. So clear are they in this judgment that it is probable the Faculty will soon seriously consider the expediency of making attendance on a summer school of mines, at the end of the second year, and a summer school of metallurgy, at the end of the third year, a positive requirement, in the first case for those who purpose to graduate in mining, and in the second case for those who purpose to graduate in metallurgy.

It is due to the Eustis Copper Mining Company, to Mr. W. E. C. Eustis, president, and to Mr. John Blue, superintendent, that acknowledgment should be publicly made for the valuable opportunities enjoyed by our students, and for the practical assistance freely rendered them.

Course I. — The most notable change in the course in Civil Engineering, in preparation for the present year, has been the introduction of a brief course in mechanism, to be followed by a course in motors. This change is in the same direction with several which have taken place during the past few years, and with others which are now in contemplation, all tending to make instruction in mechanism common to several departments of the school, and to introduce the students of these courses, to a greater or less extent, into the laboratory of mechanical engineering. The students of electrical engineering have, from the first, had the free use of the mechanical engineering laboratory, equally with the students of that department. The students in the new course in chemical engineering (hereafter to be spoken of) are, also, to be introduced largely

into the same laboratory. The students of civil engineering, as just now recited, are to take a briefer course in mechanism and in motors, while the Faculty are considering the expediency of so modifying the mining course as to present two broad lines of study in that department, the one predominantly chemical, the other predominantly mechanical, the latter containing no inconsiderable amount of instruction in mechanism and mechanical engineering.

It is thus coming about that, instead of being used by the students of one course only, the mechanical engineering laboratories are of almost as general use in the school as the laboratory of physics. This wide extension of the service of the mechanical engineering laboratories, which has been suggested, not so much from within as from without, by the course of practice in the several engineering professions, has caused a great pressure upon the accommodations of that department; and it appears to be imperative, in the immediate future, to largely increase the space devoted to this service.

In my last report, I mentioned the appointment, by the Railroad Commissioners, of Prof. Swain, of the Institute, as the bridge expert of the Board, under the statute of 1887. Prof. Swain has been since that time engaged on careful and critical studies of the railroad bridges of the Commonwealth, both in the office and in the field. The work has lasted until the present time, and is not yet completed, since every railroad bridge in the State has to be carefully scrutinized. The accident, which occurred in July last, at the Fitchburg Railroad station in this city, by which a train fell through the piled bridge, led to an investigation by Prof. Swain, under the direction of the Railroad Commissioners, regarding the causes of the accident, together with a full discussion of piled structures in general, and of their liability to decay, and to the hostile action of marine animals.

Course II. — The Mechanical Engineering department has received the following gifts during the year: an Ashworth carding engine from the Messrs. Ashworth Bros., and a complete set of Westinghouse air-brake apparatus, from the Westinghouse Air Brake Co.

The mill engineering option has been transferred to Associate Prof. Schwamb; Asst. Prof. Peabody assuming charge of the marine engineering option, and Prof. Lanza the instruction in locomotive engineering.

Among the publications issuing from the department during the year may be mentioned: —

(a.) A book of Steam Tables, calculated and published by Asst. Prof. Peabody.

(b.) Notes on Dynamometers, Planimeters, Governors, and Fly-Wheels, printed for the use of our students, but not published, by Prof. Lanza.

(c.) A Paper on the Transverse Strength of Cast Iron, presented to the Society of Mechanical Engineers, by Prof. Lanza, embodying the theses of Messrs. Cochran of the class of '85, Burgess and Vielé of '86, and Eastman and Gerrish of '88.

(d.) A Paper on Balancing the Throw of the Reciprocating parts of a Locomotive, presented to the same society by Prof. Lanza, embodying the theses of Messrs. Dewson of '85, Reynolds of '86, and Smith of '88.

(e.) A Paper on the Flow of Steam in a Tube, presented by Asst. Prof. Peabody, embodying the thesis of Mr. B. G. Buttolph, of the class of '88.

In anticipation of the thesis work of the present year, several students of the now fourth-year class did an unusual amount of investigation and experiment during the last summer, some of it consisting of tests of rather large plants.

The drawing-rooms, lecture-rooms and laboratories occupied by this department are now crowded to their utmost capacity. To get through the present year it has been

necessary to assign room 44 in the Rogers Building to this department, in addition to those already occupied by it.

In consequence of the general interest awakened in the subject of heating passenger cars by steam from the locomotive, by recent railroad accidents, the Railroad Commissioners of Massachusetts employed Prof. Lanza to examine into the systems at work in this State, and also to make an investigation of the system on trial on the Atchison, Topeka and Santa Fé Railroad, in order to ascertain what could and what could not be expected of these methods of heating cars, and thus to aid the Commissioners in deciding what legislation it was desirable to recommend in the matter. Prof. Lanza undertook his investigation in December, 1887, and completed it March 30, 1888, when he presented his report to the Commissioners. He was assisted in the experimental part of the work by Mr. A. H. Twombly, of the class of '87.

Course III. — I have already mentioned that the course of studies in the department of Mining and Metallurgy is now undergoing an extensive revision. It is probable that the next report of the President of the Institute will have much to say regarding this important department of the school; but at the present time nothing requires to be added under this head.

Course IV. — In the architectural department of the Institute no important change has occurred so far as the regular course is concerned; but much has been done to strengthen and enrich the two years' partial course, by the introduction of mathematics and French, as required subjects in the first year, and by general rearrangement of studies. The number of students in this department has increased by one half since last year, and the spirit pervading the body of students exhibits the most marked and gratifying improvement.

Course V. — In Chemistry, the most important change in the course of instruction during the year has been

through the considerable extension of the work in Industrial Chemistry. Students in this branch have been allowed one additional half-year in the industrial laboratory; and a new course of lectures in Textile Coloring has been introduced. The increased number of students in the first year has rendered it necessary to add thirty-two new desks to the laboratory of general chemistry, which now has accommodations for three hundred and twenty students.

The examination of the waters of Massachusetts, on behalf of the State Board of Health, begun in 1887, by Prof. Drown and Mrs. Richards, with a corps of assistants, in room 36 of the new building, as mentioned in my report of last year, has been continued actively down to the present time. On the 1st of December, 1888, there had been analyzed nearly 3,700 samples of water. There has recently been undertaken an examination of the ice supplies of the State, also on behalf of the Board of Health, which will be continued through the winter. This great work of the Commonwealth, for the protection of its water supplies, offers to the department of Sanitary Chemistry an exceptional opportunity for the scientific study of the subject of drinking water, concerning which there has been heretofore but imperfect knowledge.

Courses VI. and VIII. — In the various courses in Physics and Electrical Engineering, the year has not been marked by changes of magnitude, but these courses have been strengthened and modified in various ways so as to obtain greater efficiency in teaching, or a better economy of time on the part of the student, thus securing a gradual advance in the standard of the instruction given. During the school year, 1887-88, six papers from the Rogers Laboratory of Physics were published in the "Proceedings of the American Academy of Arts and Sciences," the "Technology Quarterly," or elsewhere. Three other papers are now prepared for publication, and several more will shortly be ready. These papers all contain genuine, and, in some

cases, even noteworthy, additions to our knowledge of physical phenomena or laws.

The work in Electrical Engineering has reached a stage of advancement such that the department has felt ready to assume the responsibility of laying out a course of advanced instruction, embracing electricity, analytical and applied mechanics and mathematics, which can be pursued by graduate students, and which may lead to the degree of Master of Science or Doctor of Philosophy. It is not expected, or indeed desired, for the present, that the number of such students shall be large, but the presence of a few more advanced workers could not fail to exert an excellent influence over the undergraduate students.

In the matter of apparatus, the newly acquired facilities for instruction in the theory and use of dynamo-electric machinery should be noticed. The Edison dynamo and electric lighting plant, the gift of Mr. Edison, alluded to in the report of last year, and at that date in process of installation, have been of the greatest value in this respect. To these has just been added, through the generosity of the Thomson-Houston Electric Company, a large constant-potential dynamo, a type of machine the need of which has been strongly felt both by teachers and students. The laboratory now possesses the dynamo-machines of Gramme, Brush, Weston, Edison, and the constant-potential dynamo of the Thomson-Houston Company, together with a large dynamo, devised especially for experimental purposes, and constructed by Messrs. Crane and Merriam, students of the class of 1886, in connection with their graduating theses. An alternating-current dynamo will shortly be added to these, which will make the equipment of the physical laboratory, on this side, remarkably complete.

The increase in the number of machines available, and the constancy with which they had come to be employed, owing to the large body of students in this department,

rendered it absolutely necessary to the maintenance of proper instruction, that better facilities for steady driving of these machines, as well as more space in which to operate them, should be secured. There is an element of danger in crowding too many dynamos into a small space in any room frequented by students, since the amount of shafting and belting is considerable, and largely carried near the floor. Moreover, the numerous duties necessarily imposed upon the Porter-Allen engine in the Rogers Building, which has, hitherto, been the sole motive-power of the dynamos, have rendered it too unsteady to satisfy the requirements of a class of work in which lack of steadiness is a fatal defect. These difficulties have now been removed by the allotment, to the department of Physics, of a separate room, 50 x 40 feet in area, as a dynamo-room. In this room has been placed a seventy-five horse-power Westinghouse engine, mounted upon a very solid masonry pier, and assigned solely to the work of the physical department. Suitable shafting has been provided, and the dynamos are now in process of removal from their former places to the new dynamo-room. The space left in the room formerly occupied by these machines will, for the time, at least, afford a much-needed relief to the general work of the physical laboratory.

Course VII.—The number of students of the various courses and classes entering the biological laboratory, for longer or shorter courses in microscopy, in bacteriology, or in general biology, has greatly increased during the year; and, as has already been stated, to the work of this department has been added the instruction in zoölogy and palæontology, previously given by the Custodian of the Society of Natural History.

A much-needed addition to the apparatus of the biological laboratory has been supplied by the liberality of James Means, Esq., through the presentation of an expensive and very effective form of water motor, especially

adapted for aërating aquaria and for producing artificial respiration in the experiments of practical physiology.

The most marked feature in the developments of the year, in this department, has been the increase of interest within the school, and of demands made from the outside upon the school, in connection with investigations in sanitary bacteriology. The great advances recently made in this line of investigation, and the almost limitless possibilities of the future in this respect, have not only caused the minds of many of our students to turn in that direction, but have created a demand from the outside for skilled bacteriologists, which, up to this time, the Institute has not been able fully to meet. A problem of much difficulty, affecting the disposal of sewage, has lately been referred, by the State Board of Health, to Prof. Sedgwick, for investigation; and the work thereon is now being prosecuted in the biological laboratory.

Course IX. — The body of studies in Course IX., the general course, has been still further enlarged and enriched, during the year, as a result of the appointment of Asst. Prof. Levermore, already noted.

The instruction in statistics, and in the graphic methods of representing large bodies of facts, which has been worked out by Asst. Prof. Dewey, is one of remarkable interest and usefulness. I believe that in no college of the United States is better instruction given in this important branch. Students are taught to construct diagrams and employ other modes of graphic representation, in application to a great variety of subjects, vital, industrial, commercial, and political.

Course X. — To the nine regular four-years' courses of instruction in the Institute of Technology, which have heretofore been pursued, the Faculty have this year added still another course, which is to be known as Course X., Chemical Engineering.

Eleven members of the second-year class have already

entered upon this course. A brief explanation of the general purpose for which this new department of study has been created may be of interest, not to the Corporation merely, but to the general public.

The chemical engineer has been but little known in this country or England, and perhaps not at all, under that name; although his profession is recognized in France and Germany. The chemical engineer is not primarily a chemist, but a mechanical engineer. He is, however, a mechanical engineer who has given special attention to the problems of the chemical manufacture. There are a great number of industries which require constructions, for specific chemical operations, which can best be built, or can only be built, by engineers having a knowledge of the chemical processes involved. This class of industries is constantly increasing, both in number and in importance. Heretofore, the required constructions have, generally speaking, been designed, and work upon them has been supervised and conducted, either by chemists, having an inadequate knowledge of engineering principles and unfamiliar with engineering, or even building, practice; or else by engineers whose designs were certain to be either more laborious and expensive than was necessary, or less efficient than was desirable, because they did not thoroughly understand the objects in view, having no familiarity, or little familiarity, with the chemical conditions under which the processes of manufacture concerned must be carried on. It was to meet this demand for engineers having a good knowledge of general and applied chemistry, that the course in Chemical Engineering was established.

The instruction to be given, while following mainly in the line of Mechanical Engineering, includes an extended study of Industrial Chemistry, with laboratory practice. Special investigations into fuels and draught, with reference to combustion, will be a feature of the course. The plan of study has not yet been fully marked out; but a

standing committee of the Faculty, consisting of the professors chiefly concerned, will give their attention, throughout the year, to the further development of this department, which, it is believed, will add much to the strength and usefulness of the school.

LIBRARIES.

The several libraries of the Institute have received considerable additions during the year, both by purchase, especially in the departments of history, literature, and political economy, and by the gift, from Mrs. President Rogers, of very large and very valuable collections of books and pamphlets in physics, mathematics, chemistry, geology, and natural history, from her husband's library, embracing several extensive series of scientific journals and reviews. It is hoped that, during the present year, Mr. Clement W. Andrews, of the chemical department, will be able to carry out the plan, which was last year conceived and undertaken, of making a general catalogue, that should embrace all the books of all the departments. Down to this time each department has had its own library and catalogue, but there has been no single, central place of reference, where it could be quickly ascertained whether a book were in any of the department libraries, and, if so, in which. Mr. Andrews undertook the labor of the general catalogue, at the close of the last school year; but his appointment, by the Treasury Department, to investigate the testing of sugars by the polariscope, at the more important ports of the United States, occupied the entire summer, and led to the postponement of this much-needed work.

I may add that the libraries of the Institute of Technology are, considering the general poverty of means which has been experienced throughout its entire history, of very great value. Even when the school was at the lowest ebb

in its finances, the subscriptions of the Institute to scientific and technical journals and periodicals, in almost every department, and almost the world over, were still maintained; and the result has been a very extraordinary collection of this all-important class of scientific and technical literature.

Each separate department of the Institute maintains its own library, at, of course, the expense of a certain amount of duplication, but with the inestimable advantage of inducing the freest and easiest possible use of the books by the students. The following table gives the results of the first approximate count made by Mr. Andrews, for the purpose of the contemplated catalogue:—

Chemical Department	3,200
English and Political Economy	2,700
Physics	1,850
Geological	800
Civil Engineering	1,050
General	900
Biological	720
Mining Engineering	700
Mechanical Engineering	540
Architectural	470
Margaret Cheney Reading-room	410
Total	<hr/> 13,340

STUDENT PUBLICATIONS.

During the past year the students of the Institute, upon their own motion, established two journals, intended to exhibit, in a serious manner, portions of the work done in the Institute.

The first of these journals, known as the *Technology Quarterly*, has passed through a year of trial, and the first number for the current year has already appeared. This journal is conducted by a board of editors, chosen from the two upper classes, having their own treasurer, business

manager, and advertising agent. At the request of the students, an advisory committee of the Faculty was established as one of the standing committees of that body, for the purpose of conferring with and assisting the editors in the large and difficult work which they have undertaken.

The *Quarterly* is intended to embrace the results of a portion of the original investigations conducted at the Institute by students, as well as by members of the staff of instruction; articles descriptive of new processes and methods, and other matters of scientific or technical importance, contributed by the Alumni, as well as from the Institute; reports and notes of Institute lecture courses on special subjects; and essays of a somewhat varied character. It will thus exhibit the tendency and scope of the more advanced work of the school.

The other journal referred to as established by the students during the past year is known as the *Technology Architectural Review*, conducted by the members of the department of Architecture, with the assistance of an advisory board, consisting of eminent architects in professional practice. The prospectus of this *Review* contemplates the issue of eight numbers yearly, each number comprising four or more large folio plates, exhibiting the original work of the students of the department. The seven numbers already issued have been of unexpected interest and value, and the enterprise has received cordial and even enthusiastic recognition from many of the most eminent architects of the country.

MARGARET CHENEY ROOM.

In addition to the various gifts which have been noted in connection with the several courses of study, the Margaret Cheney Reading-room, for women students, has received from the friends of the Institute, or from the especial friends of the higher education of women, several

valuable presents the past year. Foremost among them is the portrait of Mrs. Ellen H. Richards, the first woman graduate of the Institute of Technology, and, since 1878, an instructor in this school. This picture, the work of Miss Ellen Hale, was presented to the Institute, on behalf of an unknown friend, by Miss Ellen Frothingham and Miss Abby W. May. Other valuable gifts to the Margaret Cheney Room have been made by Miss Anna C. Lowell, Mrs. Edna D. Cheney, and Mrs. Mary L. Williams.

NEW BOILERS.

In addition to the numerous changes and additions of the year, which have already been recited, should be mentioned the introduction into the Rogers Building of new sectional tubular boilers, by the Babcock-Wilcox Company, of over two hundred horse-power, to take the place of two small boilers, of perhaps thirty horse-power each, which were put in when the building was erected, and which, having been in use for twenty years, have become thoroughly worn out. The new boilers, it will be observed, not only replace the worn-out old ones, but largely increase the steam-power at the disposal of the Institute, an increase rendered necessary by the rapid addition of machinery in the departments of Mechanical Engineering and Electrical Engineering.

Partly in consequence of this increase of boiler power, and partly with a view to avoid the effects of such a snow blockade as was experienced last winter, additional coal vaults, of the capacity of sixty tons, were constructed at the beginning of the present season.

THE FINANCIAL CONDITION OF THE INSTITUTE OF TECHNOLOGY.

In my report of last year, I recited the action taken by the Legislature in appropriating \$100,000 for the Institut :

of Technology, conditioned upon the establishment of twenty free scholarships; and stated the reasons which, to my mind, made it undesirable to accept this grant thus conditioned. Under instructions from the Corporation, at its December meeting, I presented to the appropriate committees of the General Court of Massachusetts, on its assembling in January, the considerations which favored a more liberal policy on the part of the Commonwealth toward this institution. The reception accorded by these committees to the views presented, the cordial recognition of the work done by this school in the past, and the good wishes of the committees for the future of the school, were most gratifying and encouraging. An appropriation of \$100,000, without conditions, in addition to the sum previously appropriated, was favorably reported by the committees of the House and of the Senate, and was passed by large majorities in both branches. A copy of the act, and also of the act of 1887, will be found appended to this report.

The relief to the finances of the Institute obtained through this free grant of \$100,000 has been very great. It has cleared the air around us. It has given fresh hope and courage to the Faculty of the school; and has strengthened the administration at a vital point. At the same time, the establishment of the free scholarships, under the State grant of the previous year, while of no pecuniary advantage to the school, has already been the means of enabling several highly deserving young men to continue their studies in the school, who, otherwise, would have been obliged to withdraw. Of the twenty scholarships provided by the act of 1887, ten were opened at the beginning of the present school year, and the other ten will be established in season for the school year 1889-90, after the second payment by the State, on this account.

In addition to the \$100,000, stated in my last report to have been raised chiefly through the exertions of Mr.

Endicott, by subscription from the friends of the school, \$30,000 have been since raised toward a second \$100,000 by the same indefatigable friend of this school and of every good word and work. It is earnestly hoped that the financial troubles of the times will not interfere with the efforts to complete this subscription, during the current year.

During the last session of the Legislature, another act affecting the finances of the school was passed upon the petition of this Corporation, viz., Chapter 72 of the Acts and Resolves of 1888, authorizing the Institute to hold real and personal estate to an amount of which the clear annual income shall be \$100,000, to be devoted exclusively to the purposes and objects set forth in an act of incorporation and the acts in addition thereto. The previous income limit, fixed by statute, had been \$30,000. That income has not yet been reached; but the recent experiences of Cornell University in being precluded from receiving a large bequest, by reason of a property limit in its charter, seemed to render it the duty of the Corporation to take the action which has been recited.

OBITUARY.

My last word is a sad one. During the year this school, like many another institution, has sustained a great and touching loss, in the death of one who had been for sixteen years a member of its Board of Trust. What land is not full of his good works? What is that kind of charitable or philanthropic effort to which he did not freely contribute by counsel, cheer, and practical assistance? The sun never set upon his beneficence, for he followed humanity around the world, to find its occasions of greatest need; and no appeal in that sacred name ever fell unheard and unheeded upon the ear of Samuel D. Warren.

CHAPTER 103, ACTS AND RESOLVES OF 1887.

Resolved, That there be allowed and paid out of the treasury of the Commonwealth the sum of one hundred thousand dollars to the corporation of the Massachusetts Institute of Technology, in the manner following: An instalment of fifty thousand dollars on the first day of December in the present year, and a final instalment of fifty thousand dollars on the first day of December in the year eighteen hundred and eighty-eight; said sums to be applied to the purposes of the Institute. And in consideration of this grant said Institute shall establish and maintain twenty free scholarships, and each senatorial district in this Commonwealth shall once in eight years, in such alternate order as the Board of Education shall at the time of the first apportionment of said scholarships determine by lot, be entitled to one scholarship for a period of four years, to be awarded to such candidates as shall be found upon examination to possess the qualifications fixed for the admission of students to said Institute, and who shall be selected by the Board of Education; preference in the award being given to qualified candidates otherwise unable to bear the expense of tuition. In case no candidate appears from a senatorial district, then a candidate may be selected from the State at large to fill such vacancy, who may continue to hold the scholarship annually until a candidate is presented from the senatorial district unrepresented, who shall then be awarded the scholarship for the balance of the time for which said district would originally have been entitled to its benefit. In case a vacancy occurs in any senatorial district after an appointment has been made, then a candidate from the same district shall be selected for the balance of the time for which said district is entitled to its benefit, or in the event of no such candidate appearing, from the State at large, upon the conditions previously set forth: *provided*, that said corporation shall secure, prior to the first payment above authorized, a further sum of one hundred thousand dollars in addition to the funds now held by it and to be applied to the purposes of the said Institute, and shall present satisfactory evidence thereof to the Auditor of the Commonwealth. [*Approved June 16, 1887.*]

CHAPTER 83, ACTS AND RESOLVES OF 1888.

Resolved, That there be allowed and paid out of the treasury of the Commonwealth, the sum of one hundred thousand dollars to the corporation of the Massachusetts Institute of Technology, in addition to the sum authorized to be paid by chapter one hundred and three of the resolves of the year eighteen hundred and eighty-seven, to be applied to the purposes of said Institute; *provided, however*, that this grant is made subject to, and conditioned upon, the establishment and maintenance of the scholarships provided for by chapter one hundred and three of the resolves of the year eighteen hundred and eighty-seven; and *provided, further*, that fifty thousand dollars of the aforesaid sum shall be paid during the year eighteen hundred and eighty-nine, and fifty thousand dollars during the year eighteen hundred and ninety. *Approved May 23, 1888.*]

[CHAP. 72.]

AN ACT TO AUTHORIZE THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY TO HOLD ADDITIONAL REAL AND PERSONAL ESTATE.

Be it enacted, etc., as follows:

SECTION 1. Section one of chapter two hundred and twenty of the acts of the year eighteen hundred and sixty-five is hereby amended to read as follows: The Massachusetts Institute of Technology is hereby authorized to hold real and personal estate to an amount of which the clear annual income shall be one hundred thousand dollars to be devoted exclusively to the purposes and objects set forth in its act of incorporation and all acts in addition thereto.

SECT. 2. This Act shall take effect upon its passage. [*Approved February 29, 1888.*]