

## Assessment of academic aeronautical research in India

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*Academic research in the aeronautical sector is confined to a narrow base. Scientometric data allow a quantitative assessment of this to be made. The current status of aeronautical research shows that many departments of aerospace engineering are working in a fragmented manner and that for the aeronautical research base to contribute significantly to the strategic development sector, it must be consolidated and increased in strength.*

There has been anecdotal suspicion and some quantitative evidence<sup>1,2</sup> that the autonomous research institutions in the country perform better at academic research than the actual university sector. Here, we take a close look at the aeronautical R&D activity in the country to see if this generalization holds true within this sector. Aeronautical research and development in India can be thought of as being pursued at two levels: the academic sector where most of basic research leading to papers is performed; and the strategic/industrial sector where most of the development, production and realization of hardware takes place. While the latter has done well and is reasonably well funded, the activity in the former has been confined to a narrow base. This analysis uses scientometric techniques to assess the topography of activity in the academic segment of aeronautical research. The present analysis is based on data from the SCOPUS database, which is still in the public domain. SCOPUS ([www.scopus.com](http://www.scopus.com)) is an Elsevier product, which is all set to become the single largest scientometric database with more than 27 million abstracts and citations covering 14,500 journals from 4000 publishers.

### Methodology

The SCOPUS database was interrogated for all records of papers published by scientists/academicians from that part of the R&D activity in the aeronautical sector in the country, that has resulted in publication in peer-reviewed journals. The database will naturally indicate only those individuals who have papers published in journals covered by the database. This set will vary according to how exclusive or inclusive the database is. SCOPUS is probably the largest scientometric database today and it is particularly generous to

Indian journals, covering about 150 or so. The search strategy was built round the use of the strings (AERO\*) AND (INDIA) for the field of affiliation. The search was confined to all years after 1995, for which SCOPUS assures a complete coverage, as records for earlier years are sketchy. Any paper appearing in the SCOPUS database during this period and which had at least one author in an institution from India that had the string AERO in its name, was identified. The leading institutions picked up by the search process were:

National AEROSpace Laboratories (NAL); AERONautical Development Agency; AERONautical Development Establishment; Department of AEROSpace Engineering, IISc; Department of AEROSpace Engineering, IIT-Kanpur; Department of AEROSpace Engineering, IIT-Kharagpur; Department of AEROSpace Engineering, IIT-Madras; Department of AEROSpace Engineering, IIT-Bombay.

While the departments have as their main mandate, academic research, it was found that among the aeronautical institutions in the autonomous research sector, NAL had a significant presence in the academic plane. All authors who have over five papers in this ten-year period were selected for ranking, as this was felt to be a good criterion for research excellence (one *SCI* paper every two years is an accepted international benchmark for good research performance).

### Results and discussions

Altogether, 117 scientists/authors in the country published more than five papers each during the period 1996–2005, as recorded in the SCOPUS database. Among these, 101 were from the following six institutions: 33 from NAL; 29 from Department of Aerospace Engineering, IISc; 13 from Department of Aerospace Engineering, IIT-Kanpur; 10 from Department of

Aerospace Engineering, IIT-Kharagpur; 9 from Department of Aerospace Engineering, IIT-Madras, and 7 from Department of Aerospace Engineering, IIT-Bombay.

If a stricter criterion is used, as for example, considering a threshold of ten papers during this period instead of 5, only 48 scientists/authors in the country make it to the list of top performers. Among this, 46 are from the institutions listed above. The distribution remains of the same type, with 13 from NAL, 16 from IISc, 7 from IIT-Kanpur, 3 from IIT-Kharagpur, 4 from IIT-Bombay and 3 from IIT-Madras.

Note also that as the assessment is guided by considering only the excellence of research, and not on the productivity of the institution as a whole, the total number of scientists/academicians (includ-

**Table 1.** List of 101 leading scientists/authors from six leading institutions and their papers

No. of papers	No. of scientists/authors
58	1
36	1
35	1
27	1
25	2
24	1
23	1
22	2
21	3
19	1
17	4
16	1
15	3
14	2
13	3
12	4
11	9
10	5
9	9
8	8
7	16
6	14
5	9

**Table 2.** Filling-up of national ranks in institutional rank matrix

Institutional rank	Filling-up of national ranks					
	NAL	IISc	IIT-Kanpur	IIT-Kharagpur	IIT-Madras	IIT-Bombay
1	4	3	6	1	10	2
2	9	8	7	5	42	26
3	12	15	11	24	45	29
4	13	16	14	53	51	34
5	17	20	18	57	60	88
6	19	21	30	61	64	93
7	25	22	33	77	85	111
8	35	27	71	79	115	
9	38	28	74	100	116	
10	41	31	86	112		
11	43	32	91			
12	47	36	94			
13	48	37	106			
14	49	40				
15	50	44				
16	54	46				
17	55	52				
18	56	62				
19	63	65				
20	66	67				
21	72	69				
22	78	70				
23	80	75				
24	82	76				
25	83	81				
26	87	104				
27	92	108				
28	95	110				
29	98	117				
30	103					
31	105					
32	107					
33	109					

ing research scholars) working in each of these organizations is not taken into consideration. Also, a partial count approach is used, so that where there are papers with multiple authors from the same or even different organizations, these have been counted separately for each author.

Table 1 shows the productivity in terms of papers published when the threshold is set at five papers in the period 1996–2005. All 117 scientists are then ranked according to the number of papers published on a national basis and on an institutional basis. Thus, the author with 58 papers during this period is ranked no. 1 in the country as well as no. 1 at his institution, in this case IIT-Kharagpur. Table 2 introduces a matrix which indicates how these ranks fill up at an institutional level. This author has found after long years of experimentation that the filling-up procedure is the best way to compare entities for performance. Figure 1 illustrates the filling-up procedure graphically. The

gentler slopes indicate dominance in performance. The outstanding performance of NAL, matching that of the Department of Aerospace Engineering, IISc, is remarkable and unexpected. We also see clearly that the IIT departments are far too fragmented. To see how they perform if the departments are merged, the filling-up matrix and the graphical illustration of this are repeated in Table 3 and Figure 2. It is clearly seen that if the aerospace departments at the IITs are merged into one entity and managed accordingly, the performance is comparable to that of the other two major players.

### Some thoughts on performance of NAL and the triple helix dynamics

Triple helix dynamics is the name given to the roles that university, government and industry play in furthering research and development<sup>1</sup>. We had seen earlier<sup>2</sup>

that the autonomous research institutions in the country, which are mainly in the government sector, contribute far more than their fair share to academic research going on in the country. As a quintessential CSIR institution belonging to this sector, the main mandate of NAL is principally as a provider of end-to-end technological solutions to the aerospace industry and the strategic sector. Yet, we see from the present scientometric assessment that even in academic research, NAL has contributed handsomely to the body of peer-reviewed research publications coming out from the country. This is in one sense as remarkable as it is unexpected. The other side of the coin is that beyond the IISc and the IITs, there is little high quality academic research from the university sector going on in the country. This analysis also confirms that the industrial sector hardly contributes to academic research in aeronautical engineering. The departments of aeronautical engi-

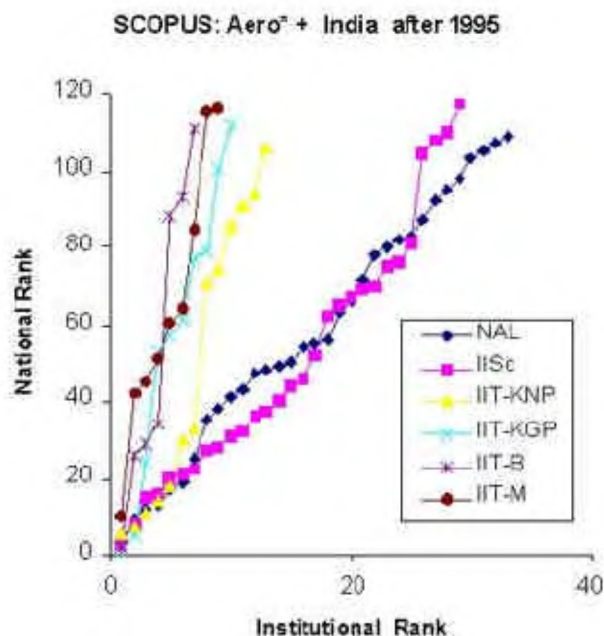


Figure 1. Filling-up procedure illustrated graphically. Gentler slopes indicate dominance in performance.

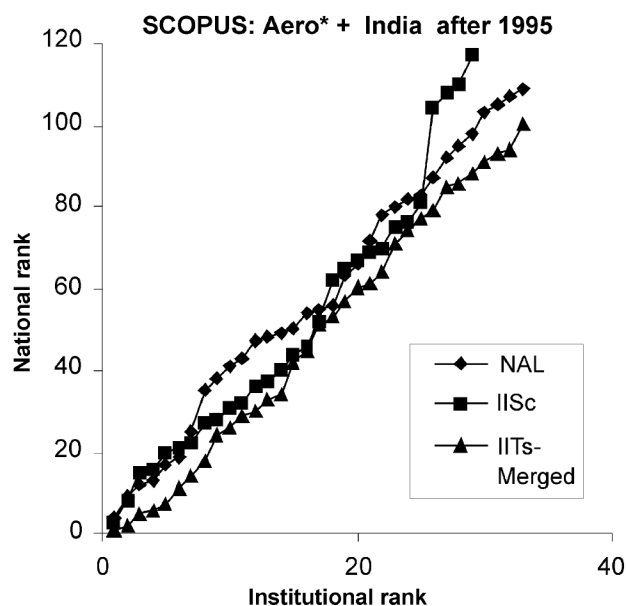


Figure 2. Filling-up procedure illustrated graphically, after the aerospace departments of the IITs are merged. The combined IIT effort is now comparable with the performance of the other two major players.

Table 3. Filling-up of national ranks in institutional rank matrix after IITs are merged

Institutional rank	Filling-up of national ranks			Institutional rank	Filling-up of national ranks		
	NAL	IISc	IITs-merged		NAL	IISc	IITs-merged
1	4	3	1	20	66	67	60
2	9	8	2	21	72	69	61
3	12	15	5	22	78	70	64
4	13	16	6	23	80	75	71
5	17	20	7	24	82	76	74
6	19	21	11	25	83	81	77
7	25	22	14	26	87	104	79
8	35	27	18	27	92	108	85
9	38	28	24	28	95	110	86
10	41	31	26	29	98	117	88
11	43	32	29	30	103		91
12	47	36	30	31	105		93
13	48	37	33	32	107		94
14	49	40	34	33	109		100
15	50	44	42	34			111
16	54	46	45	35			112
17	55	52	51	36			115
18	56	62	53	37			116
19	63	65	57				

neering at the IITs are too fragmented and dispersed and much would be improved by way of creating critical mass and also by enhancing multi-disciplinarity if they can be consolidated into a single aeronautical institution. It is also obvious that much more encouragement

is needed to widen the base that performs open-ended and basic research in the aeronautical sciences in all three sectors, university, government and industry.

1. Leydesdorff, L., *Scientometrics*, **58**, 445–467.

2. Prathap, G., *Curr. Sci.*, 2004, **87**, 732–734.

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