

# The Impact of the Aerospace Science Engineering Program at Tuskegee University

Eric J. Sheppard, Vascar G. Harris

Aerospace Science Engineering Department  
Tuskegee University  
Tuskegee, AL 36088

## Abstract

The engineering programs at Historically Black Colleges and Universities play a significant statistical role in the production of African-American engineers. An example is Tuskegee's Aerospace Science Engineering Department, which has produced up to one fifth of the African American aerospace engineering B.S. degrees in some years. Given this information, the department is making plans for its future.

## I. Introduction

There has been much discussion of the under-representation of African Americans in the field of engineering, and both causes and effects have been analyzed. References 1 and 2 are examples concerned with retention issues that are particularly relevant to this paper. Some of the key issues identified in these references are the importance of financial aid resources and the complexity of addressing minority retention rates that lag far behind the retention rates of non-minorities. In response, many universities across the country set up programs to help recruit and retain underrepresented groups. This under-representation is also of interest to the HBCUs with engineering programs, and this paper discusses their role in the effort to produce a more diverse pool of engineers, specifically the impact of Tuskegee University's Aerospace Science Engineering Department.

Booker T. Washington, founding President of what is now Tuskegee University, stated "that in proportion as the Negro learned to produce what other people wanted and must have, in the same proportion would he be respected."<sup>3</sup> This is a cornerstone of Tuskegee's educational philosophy and reflects a common sense (if sometimes judged optimistic) goal of the Historically Black College and Universities (HBCUs).

This paper first looks at the impact of HBCU engineering schools in general. Nine accredited engineering schools at HBCUs awarded degrees throughout the entire period covered by this paper. Although these nine schools represented a small fraction of all engineering schools in the U.S., these institutions awarded approximately one quarter of the U.S. engineering B.S. degrees awarded to African-Americans (A/A). Second, the impact of the Aerospace Science Engineering (ASE) Department at Tuskegee University (TU) is considered. Over the years focused on in this paper, the ASE department was the only accredited Aerospace Engineering program at an HBCU

and the number one producer of African-American aerospace engineers at the B.S. level. Following a discussion of such data, some ideas for future development of the ASE department are addressed.

## II. The Impact of HBCU Engineering Schools

Today's HBCUs with engineering programs can provide unique opportunities to both African American students and faculty, which may arise from one or more of the following general objectives:

- to identify and train talented African Americans interested in the engineering profession, some of whom may have weak educational backgrounds,
- to effectively educate students so that upon graduation they can excel in their chosen engineering discipline,
- to introduce the rich heritage of science and engineering achievement of their community (at Tuskegee, this would include the examples of George Washington Carver and the Tuskegee Airmen), and
- to support, develop, and nurture the careers of African American engineers in government, industry, and academia, so that they may provide continuing leadership in the future.

This is not an easy list of objectives to maintain, particularly with limited resources. However, it remains critical that HBCUs maintain science and engineering excellence inside and outside the classroom.<sup>4</sup> This commitment to our students is critical since such a significant portion of African-American scientists and engineers pass through HBCU doors for at least part of their education. As an example, Table 1 shows B.S. degrees awarded in engineering at HBCU engineering programs to African-Americans. From 1988/1989 to 1996/1997, the nine institutions listed doubled their degree production. This is significant growth, and comes at the same time that several of these programs expanded their graduate programs and added Ph.D. programs.

Table1: Engineering B.S. Degrees Awarded to African Americans at HBCUs in selected years<sup>5-9</sup>

	88/89	89/90	93/94	94/95	96/97
Alabama A&M			3	5	3
Tuskegee	64	84	113	100	130
Howard	113	105	88	99	86
FAMU	4	22	62	113	98
Southern	73	62	60	69	92
Morgan State	18	17	52	24	66
NCA&T	90	100	171	232	256
TSU	27	53	25	41	37
Prairie View	78	80	139	110	163
Total, these schools	467	523	713	793	931

(In this table and all others, schools are listed alphabetically by state. Note that the years included in all tables in this paper were those for which data could be found, and represent the very early years of the TU ASE department (88/89 and 89/90; the department's first graduate

was in 1987), the years when the department had reached a reasonably steady number of graduates (93/94 and 94/95), and a more recent year (96/97).)

Table 2 shows the relative impact that nine HBCU engineering have had on African-American B.S. engineering degree attainment for the selected years. These nine programs are responsible for close to half (464) of the national growth (1091) between the 1989/1990 and 1996/1997 academic years. The portion of African-Americans receiving B.S. degrees in engineering that received them from these nine schools has steadily increased over these same years, indicating that these schools remain significant.

Table 2: HBCU Contributions to African American (A/A) Engineering Degrees<sup>5-9</sup>

	88/89	89/90	93/94	94/95	96/97
Total Engineering B.S. Degrees	68824	65967	64946	64749	65091
Eng. B.S. Degrees to A/A	2112	2173	2769	2897	3203
A/A Degrees as Percent of total	3.1%	3.3%	4.3%	4.5%	4.9%
HBCU Eng. B.S. Degrees to A/A	467	523	713	793	931
Percentage of A/A Eng. Degrees at HBCUs	22.1%	24.1%	25.7%	27.4%	29.1%

HBCUs with engineering programs were four of the top seven baccalaureate origins of engineering doctorates awarded between 1991 and 1995.<sup>10</sup> Tuskegee was tied for seventh on this list with five of its alumni receiving doctorates in engineering between 1991 and 1995. North Carolina A&T and M.I.T. were the top baccalaureate origin over that period, with nine doctorates each. It is interesting to note that these doctorate figures occurred before the growth in B.S. production at the HBCUs with engineering programs.

### III. The Impact of the Tuskegee Aerospace Science Engineering Program

The Aerospace Science Engineering Department at Tuskegee University is an ABET-accredited<sup>11</sup> program that enrolled its first students in 1984, and had its first graduate in 1987. The Department continues the legacy of excellence in aviation that was established by the Tuskegee Airmen nearly 60 years ago.

Table 3 focuses on Aerospace Engineering B.S. degrees awarded to African-Americans at selected schools for selected years. While Tuskegee is the largest producer over the years cited, there are several other schools awarding significant numbers of degrees as well. Amongst these are some of the largest and most highly ranked aerospace programs in the United States.

Table 3: African American Aerospace Engineering B.S. Degrees Awarded, selected schools, selected years<sup>5-9,12</sup>

	88/89	89/90	93/94	94/95	96/97
Tuskegee#	0	9	13	10 (9)	13 (18)
Embry Riddle*	5	1	2	1	1
Air Force Acad.	2	1	3	2	0
Georgia Tech	2	1	0	3	5
Purdue	3	0	3	1	3
U. Maryland	5	3	2	4	2
Naval Academy	0	2	3	3	2
M.I.T.	2	4	3	3	3
U. Michigan	2	1	4	5	3
Mississippi State	1	1	1	2	5
Polytechnic (NY)	4	0	4	3	1
Ohio State	1	1	1	2	0
Total A/A Aerospace B.S.	56	48	66	56	60
Total Aerospace B.S. in U.S.	3065	2971	2311	1789	1372
A/A Aero. B.S. as Percentage of U.S. Aero. B.S.	1.8%	1.6%	2.9%	3.1%	4.4%

# Department records differ from AAES numbers in years 94/95 and 96/97. Department figures are used in each case. The AAES figure is shown in parentheses.

\* Both locations combined (Arizona and Florida)

Table 4 looks at enrollment by year in fall 1997 for different student cohorts. The purpose of this table is to compare the enrollment profile in the TU ASE department with overall national profile, and that for African-Americans nationally, state of Alabama, and aerospace students in particular. Although low retention remains a critical issue for the department at Tuskegee,<sup>1,12</sup> the general enrollment sequences are similar across the different groups of students compared in table 4. It is interesting to note that the Tuskegee aerospace program, representing less than 1% of the total U.S. aerospace enrollment (1997 figures), represents approximately 20% of the African-American enrollment in fall 1997 and of the degrees awarded in 1996/1997.

Table 4: Comparison of Fall 1997 Enrollment Figures<sup>13</sup>

	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
All U.S. Engineering Students	90882	67879	68812	92496	6389	326458
All Alabama Engineering Students	2242	1253	1173	1847	15	6530
All Alabama A/A Engineering Students	478	244	200	341	2	1265
All U.S. Aerospace Students	2174	1531	1411	1943	78	7137
All U.S. A/A Aerospace Students	103	65	53	71	2	294
Tuskegee A/A Engineering Students	151	95	81	181	0	508
Tuskegee A/A Aerospace Students	17	11	9	23	0	60

The ASE Department maintains informal tracking of past graduates. For example, of the fifteen 1995-1996 graduates, three went into the military, nine went into industry, and three went to graduate school. Of the thirteen 1996-1997 graduates, two went into the military, ten went into

industry, and one went to graduate school (this student deferred his military commission). In the spring of 1998, five ASE alumni received their M.S. degrees (not all in aerospace engineering, but all in engineering) from Penn State, Clarkson, Purdue, Embry Riddle (FL), and Cincinnati.

#### IV. Development of the Tuskegee Aerospace Science Engineering Department

The figures above are useful in the Aerospace Science Engineering Department's planning for the future. They help in measuring the impact and effectiveness of the mission of the department and in the evolution of the department's vision for the future. Analysis of such trends will be also be a part of the department's outcomes assessment in the ABET Engineering Criteria context.<sup>11</sup>

Tuskegee's planning must take into consideration its role in the HBCU community. The relevance of HBCUs in the post-segregation United States is often debated. Questions from the general public about the academic rigor and faculty quality at HBCUs arise despite the continuing contributions of these schools and their graduates.<sup>14</sup> On the other hand, we recognize the efforts of the HBCUs which are aiming at being the first quality choice of African-American and other students. This takes a solid financial support and faculty and administrative commitment.<sup>15</sup>

For a broader perspective, the department needs to look to resources such as the Industry-University-Government Roundtable for Enhancing Engineering Education<sup>16</sup> (IUGREE). The IUGREE has considered several topics for reform of engineering education. Among these are the following:

- Curricular content
- Educational methodology
- Implications of Information Technology
- Life-long learning
- Integration of education and research
- Bridge building (industry-university-government)

We conclude this paper with some possible teaching, research, and service developments for the Aerospace Science Engineering Department.

##### A. Teaching

A new curriculum was developed in anticipation of the ABET Engineering Criteria 2000, and was phased in starting in the fall, 1998 semester. The "new" curriculum was developed to increase the department's contact with first and second year students, enhance the design content of the program, and to accommodate the EC 2000 criteria and assessment guidelines.

Computer and intranet/internet resources need to be used more effectively for communication amongst prospective, current, and current students, faculty, and practicing engineers. Course administration and delivery can be enhanced through careful choice of web use, and plans are

underway to improve the effectiveness of the department's web presence for all of its constituents.

The department needs to establish a working plan for integrating outcomes assessment into its routine operations. This assessment will help in continuously monitoring, understanding, and ultimately addressing the department's retention rate.

## B. Research

The research interests of the department include flight simulation, materials and structures, aerodynamics, and propulsion. Sustained research activity and the associated funding provide laboratory experiences for students inside and outside of the classroom. Such scholarly work also keeps faculty current and involved in their areas of interest.

The department needs to expand its horizons to consider funding opportunities for technical and educational research that do not specifically encourage HBCU participation. As the department develops its teaching and service directions, the research portfolio must be kept in mind, and updated as needed. The department presently does not have a graduate program (but faculty may work with Mechanical Engineering graduate students), but does have a plan to phase in a M.S. in Aerospace Science Engineering. A department advisory committee will provide critical direction.

## C. Service

Service is a crucial component for all academic units. The community served by Tuskegee's Aerospace department includes students, engineers, and others interested in aerospace issues, the African-American community, and the local Macon County, AL area – these are our constituents. The Internet is an obviously exciting possibility to connect all of these groups, and the department web site could be used as an educational, career, and communication gateway. This should involve developing, through appropriate University channels, a relationship with the Tuskegee Airmen, and the Tuskegee Airmen Museum, now in its planning stage.

## V. Conclusions

The HBCUs with engineering programs play a critical role in the production of African-American engineers who are ready to contribute to the nation. The Aerospace Science Engineering Department at Tuskegee University has played a similar significant role in producing African American aerospace engineers. In both cases, recruitment and retention issues remain.

## VI. Acknowledgments

The first author would like to acknowledge two educators who helped to form some of the ideas that led to this paper. Dr. Kwasi Bofah, former Head of the Aerospace Science Engineering

Department, initiated several reforms in the department and continues to be available for discussions on aerospace topics and engineering education. Dr. Jennie Patrick, the former 3M Eminent Scholar at TU, has shown what an uncompromising focus on excellence in education can do, and always brings both industry and academic experience to discussions of engineering and engineering education.

#### Bibliography

1. Georges, A.; "Keeping What We've Got: The Impact of Financial Aid on Minority Retention in Engineering"; *Research Letter*; Vol. 9, No. 1; NACME; NY; 1999
2. Reichert, M. and Absher, M.; "Taking Another Look at Educating African American Engineers: The Importance of Undergraduate Retention"; *Journal of Engineering Education*; Vol. 86, No. 3; ASEE; Washington, D.C.; 1997
3. Washington, B. T.; *Up From Slavery*; Dover Thrift Edition; NY; 1985 (Originally 1901)
4. Culotta, E.; "Black Colleges Cultivate Scientists"; *Science*, Vol. 258, 13 November 1992; AAAS; Washington, D.C.; 1992
5. Engineering and Technology Degrees 1989 Part III – By Minorities; Engineering Manpower Commission of the American Association of Engineering Societies; Washington, D.C.; 1989
6. Engineering and Technology Degrees 1990 Part III – By Minorities; Engineering Manpower Commission of the American Association of Engineering Societies; Washington, D.C.; 1990
7. Engineering and Technology Degrees 1994; Engineering Workforce Commission of the American Association of Engineering Societies; Washington, D.C.; 1994
8. Engineering and Technology Degrees 1995; Engineering Workforce Commission of the American Association of Engineering Societies; Washington, D.C.; 1995
9. Engineering and Technology Degrees 1997; Engineering Workforce Commission of the American Association of Engineering Societies; Washington, D.C.; 1997
10. Reichert, M. and Absher, M.; "Graduate Engineering Education of Underrepresented Populations"; *Journal of Engineering Education*; Vol. 87, No. 3; ASEE; July 1998
11. Accreditation Board of Engineering and Technology; [www.abet.org](http://www.abet.org)
12. Aerospace Science Engineering Department Records; Tuskegee University; Tuskegee, AL; 1989 - 1997
13. Engineering and Technology Enrollment; Engineering Workforce Commission of the American Association of Engineering Societies; Washington, D.C.; 1997
14. Henry, T.; "Historically Black Colleges and Universities: Still Relevant"; article on [Africana.com](http://Africana.com) at [www.africana.com/index\\_20000727.htm](http://www.africana.com/index_20000727.htm) ; copyright 1999-2000 by Africana.com
15. Fields, C.; "Leading from Behind: Two Historically Black Colleges aspire to become more than just feeder schools"; *Black Issues in Higher Education*; March 19, 1998
16. McMasters, J., White, B., and Okiishi, T.; "Industry-University-Government Roundtable for Enhancing Engineering Education (IUGREE)"; 36<sup>th</sup> Aerospace Sciences Meeting & Exhibit, Jan. 12-15 1998, Reno, NV; AIAA 99-0281; AIAA; Reston, VA; 1998

#### ERIC J. SHEPPARD

Dr. Eric J. Sheppard is an associate professor and former Acting Head of the Aerospace Science Engineering Department at Tuskegee University. His research interests include electric space propulsion and reacting flows, and his teaching interests include design and propulsion. Dr. Sheppard is presently on leave from Tuskegee University.

#### VASCAR G. HARRIS

Dr. Vascar G. Harris is a Professor and Interim Head of the Aerospace Science Engineering Department and former Dean of Engineering and Architecture at Tuskegee University. His research and teaching interests include aerodynamics (experimental, analytical, and numerical) and design.