Age Distribution Among NASA Scientists and Engineers

by Michael L. Ciancone

The loss of technical expertise through attrition in the technical work force is a growing concern throughout NASA and the aerospace industry, and may impact on the way NASA manages projects. An unusual distribution of age groups among scientists and engineers (S&Es) within NASA presents both challenges and opportunities to NASA managers.

This article documents historical age-related S&E information within NASA in general, and the NASA Lewis Research Center (LeRC), Cleveland, Ohio, in particular, for 1968 through 1988, and discusses the implications for NASA managers. Recommendations are made for addressing the age distribution issue to provide a practical approach for avoiding adverse consequences and for allowing us to take advantage of opportunities that may arise.

The reputation of any technical organization is based on the individuals who comprise its work force, including both supervisory and nonsupervisory S&Es. These individuals form the core of the organization's technical and programmatic memory. It is essential to the viability of these organizations that they maintain a critical core of experienced individuals. Equally important is the need to attract, develop, and retain individuals who will comprise the agency work force in the years to come. This is the challenge of balancing short-term needs (i.e., utilizing existing experience to meet current demands) and long-term needs (i.e., developing new talent to meet projected demands).

Early in the U.S. civilian space program, following the formation of NASA in 1958, many S&Es were hired directly out of college by NASA, supplementing those who made the transition from the former NACA and those who were drawn from military programs. These young S&Es acquired invaluable experience as they matured along with NASA through the U.S. civilian manned space programs, including the Mercury, Gemini, and Apollo programs.

In the late 1960s, forces external to NASA (e.g., congressional and administration priorities, and budget constraints) dictated a decrease in the size of the NASA workforce (and a corresponding decrease in the number of S&Es) as the Apollo program drew to a premature close.[1] More recently, an influx of new hires in the early 1980s has helped to bolster the NASA S&E base in support of a revitalized mission, including programs such as Space Station Freedom. As a result, we are faced with a combination of a large number of S&Es nearing retirement age, a shortage of mid-career S&Es, and a large cadre of relatively inexperienced S&Es. Aggravating the situation is an anticipated downturn in the number of S&E graduates who will be available to the agency in the coming years.

If we assume that the S&Es hired in 1958 were recent college graduates with an average age of 22, then these employees will be eligible to retire under the existing Civil Service Retirement System (CSRS) in 1991, i.e., with at least 30 years of service and at 55 years of

age. Current personnel statistics reflect an average retirement age among NASA S&Es of 60.[2] The impact produced by the introduction of the Federal Employee Retirement System (FERS), supplanting the "golden handcuffs" of the CSRS, have yet to be fully determined.

The following information was obtained from raw data and annual work force summary reports prepared by the NASA Personnel Evaluation and Analysis Division for the years 1968 through 1988 to determine our current situation in light of relevant historical trends. NASA S&Es are defined by the following position categories: support engineering and related positions, aerospace technology (AST) S&E positions, and life science positions.

Support engineering and related positions include professional physical science, engineering, and mathematics positions in work situations not identified with aerospace technology. AST S&E positions include professional scientific and engineering positions requiring AST qualifications, and professional positions engaged in aerospace research, development, operations, and related work including the development and operation of specialized facilities, and supporting engineering. Life science positions include life science professional positions not requiring AST qualifications, and medical officers and other positions performing professional work in psychology, the biological sciences, and professions that support the science of medicine such as nursing and medical technology.

Figure 1 shows the general trend in both the total number of NASA civil service workers (CSs) and the number of CS S&Es. However, Table 1 indicates that, throughout the variations in the size of the NASA CS workforce, the percentage of S&Es in the total NASA CS workforce increased — from 36.5 percent in 1963 to 54 percent in 1988. This increase was not unexpected as many former CS, non- S&E

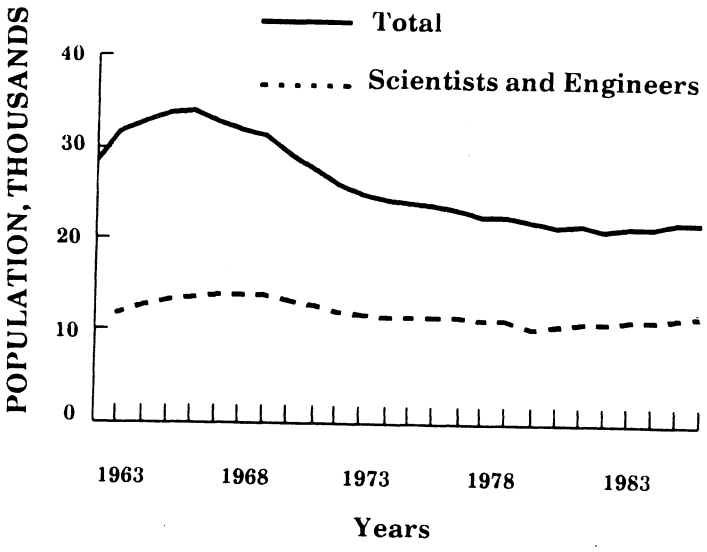

Figure 1. - NASA Civil Service Workforce

YEAR	TOTAL	S & Es	S & Es as a percent of total
1963	28,358	10,340	36.5
1964	31,285	11,893	38.0
1965	32,697	12,838	39.3
1966	33,538	13,282	39.6
1968	33,677	13,681	40.6
1968	32,471	13,851	42.7
1969	31,733	13,839	43.6
1970	31,223	13,837	44.6
1971	29,478	13,227	44.9
1972	27,428	12,616	46.0
1973	25,955	12,085	46.6
1974	24,854	11,770	47.4
1975	24,333	11,665	47.9
1976	24,039	11,612	48.3
1977	23,569	11,544	49.0
1978	23,169	11,465	49.5
1979	22,633	11,291	49.9
1980	21,613	11,200	49.5
1981	21,844	10,923	50.0
1982	21,186	10,746	50.7
1983	21,505	11,094	51.6
1984	21,050	10,879	51.7
1985	21,423	11,144	52.0
1986	21,228	11,147	52.5
1987	21,831	11,679	53.5
1988	21,991	11,866	54.0

Table 1. - NASA Civil Service Workforce

positions were converted to positions involving activities that could be provided by private industry. Although these mandated conversions contributed to the depletion of in-house talent, a conscious effort was made by NASA management to retain the technical expertise of the S&E workforce as much as possible.

Figure 2 illustrates the changing age distribution among NASA S&Es, at 10-year intervals. Table 2 tabulates the NASA S&E age data for 1968 through 1988. NASA has gone from a "young" agency in 1968 during the height of Apollo, to a somewhat normal age distribution in 1978, to the current bimodal age distribution.

A bimodal age distribution, i.e., with two distinct peaks or modes, may preclude a smooth personnel transition as experienced senior

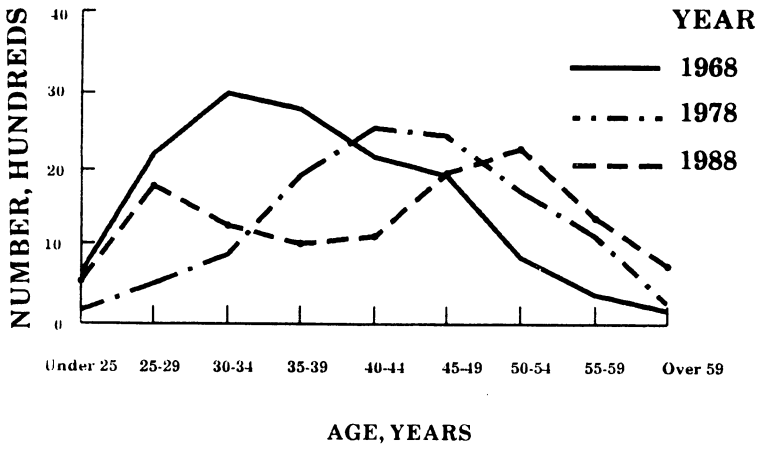

Figure 2. - Age Distribution Among NASA Scientists and Engineers

S&Es are succeeded by available personnel, consisting of a relatively few mid-career S&Es and relatively inexperienced S&Es. Since 1968, 19 to 23 percent of the total S&E popu-

YEAR	AGE RANGE									TOTAL
	< 25	25 - 29	30 - 34	35 - 39	40 - 44	45 - 49	50 - 54	55 - 59	≥ 60	
1968	633	2,168	2,945	2,767	2,136	1,874	815	347	166	13,851
1969	459	1,946	2,849	2,829	2,150	2,097	900	406	203	13,839
1970	381	1,718	2,658	2,914	2,235	2,167	1,085	472	207	13,837
1971	286	1,396	2,435	2,837	2,243	2,103	1,248	477	202	13,227
1972	135	1,109	2,185	2,746	2,383	1,950	1,452	453	203	12,616
1973	89	801	2,000	2,594	2,517	1,900	1,559	467	158	12,085
1974	108	606	1,769	2,524	2,541	1,888	1,684	486	164	11,770
1975	153	521	1,537	2,408	2,608	1,962	1,701	594	181	11,665
1976	186	468	1,308	2,264	2,662	2,050	1,738	736	200	11,612
1977	167	456	1,063	2,072	2,574	2,314	1,685	974	239	11,544
1978	176	503	874	1,928	2,528	2,406	1,683	1,098	269	11,465
1979	199	503	728	1,744	2,475	2,482	1,671	1,175	314	11,291
1980	349	598	725	1,544	2,379	2,562	1,733	977	333	11,200
1981	317	666	725	1,343	2,212	2,551	1,772	952	385	10,923
1982	328	710	660	1,159	2,060	2,475	1,927	966	461	10,746
1983	602	809	709	958	1,940	2,454	2,049	1,034	539	11,094
1984	557	909	706	842	1,723	2,379	2,091	1,074	598	10,879
1985	636	1,168	781	837	1,508	2,269	2,171	1,137	637	11,144
1986	549	1,375	887	862	1,327	2,120	2,207	1,183	637	11,147
1987	627	1,612	1,055	916	1,229	2,044	2,206	1,307	683	11,679
1988	522	1,755	1,243	993	1,102	1,960	2,253	1,328	710	11,866

Table 2. - Number of NASA Scientists and Engineers

lation has consistently been concentrated in the peak age group. The percentage of S&Es between 30 and 50 years of age has steadily decreased since 1970, while the percentage of S&Es over 50 has steadily increased (although at a slightly lower rate of increase than the rate at which the percentage between 30 and 50 decreased). In addition, the decreasing trend in the percentage of S&Es under 30 was reversed about 1980. As of 1988, 19 percent of NASA S&Es are under 30, and 36 percent are over 50.

The NASA-LeRC data represents a microcosm of NASA's S&E age distribution trends. Figure 3 presents NASA-LeRC S&E data (tabulated in Table 3), comparable to the NASA S&E data presented in Figure 2. During this time period, NASA-LeRC S&Es constituted 10 to 13 percent of NASA's S&E work force.

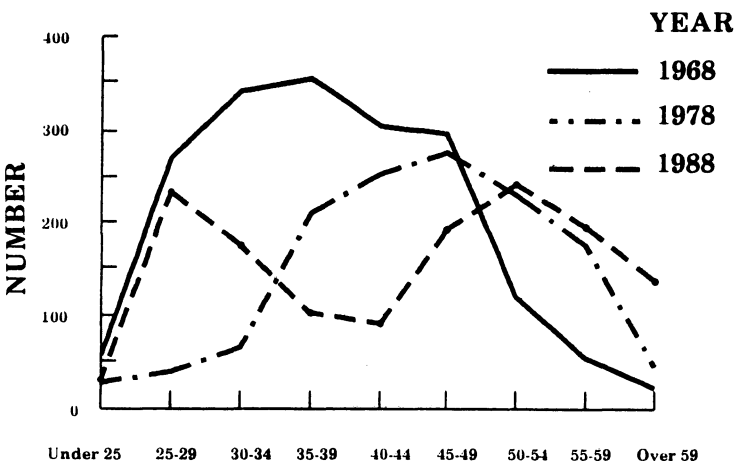

Figure 3. - Age Distribution Among NASA LeRC Scientists and Engineers

Figure 4 illustrates that the average age of NASA's S&Es increased at a rate of 0.65 years/year between 1968 and 1978. NASA's

YEAR	AGE RANGE									TOTAL
	⟨25	25-29	30-34	35-39	40-44	45-49	50-54	55-59	≥60	
1968	56	271	340	355	301	296	118	53	22	1,812
1969	35	233	321	342	294	326	138	57	32	1,778
[a]1970	27	194	312	331	302	329	170	66	28	1,757
1971	19	154	302	320	309	332	202	75	23	1,736
1972	12	102	271	306	308	287	238	73	31	1,628
1973	6	66	223	265	300	260	249	67	22	1,458
1974	5	43	188	256	286	245	245	73	22	1,363
1975	6	38	153	254	271	265	242	89	25	1,343
1976	18	34	111	244	270	262	250	128	31	1,348
1977	25	36	90	230	260	268	240	158	32	1,339
1978	28	40	64	209	253	276	228	173	43	1,314
1979	29	42	58	177	247	285	220	197	47	1,302
1980	27	50	57	141	251	266	244	155	47	1,238
1981	19	59	52	116	240	253	226	157	61	1,183
1982	33	66	49	96	226	239	212	151	72	1,144
1983	133	98	80	73	213	236	227	148	88	1,296
1984	122	112	79	64	180	240	233	156	91	1,277
1985	114	176	87	74	146	247	226	173	94	1,337
1986	46	218	92	75	122	231	230	161	104	1,279
1987	56	249	127	92	108	228	229	164	120	1,373
1988	32	231	174	101	90	190	242	195	137	1,392

Table 3. - Age Distribution Among NASA LeRC Scientists and Engineers
[a] Figures for 1970 were obtained through interpolation of the data from 1969 and 1970

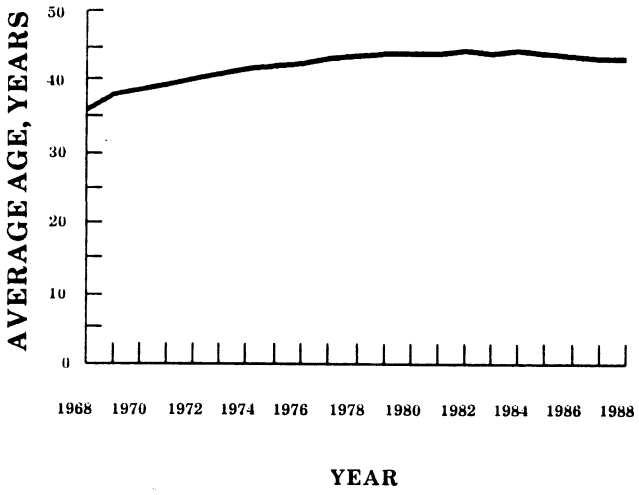

Figure 4. - Average Age of NASA Scientists and Engineers

S&E aging trend, both at LeRC and throughout the agency, has stabilized since 1979, primarily as a result of the infusion of S&E new hires and the inevitable loss of senior S&Es.

Recommendations

The following list of recommendations addresses several facets of a plan of action that will allow us to take advantage of opportunities and successfully face challenges. It includes measures that are extensions of or variations on existing NASA initiatives and is intended to be as practical as possible to facilitate implementation at the lowest possible organizational level without necessitating either an act of Congress or an act of God.

Hire Experienced S&Es

Perhaps the most obvious course of action when faced with a low level of in-house experience is to look outside the organization for available talent. However, it may not be feasible to replenish the pool of experienced personnel by hiring from outside NASA if the bimodal age distribution among NASA S&Es is indicative of the situation in the aerospace industry in general. Discussions with S&Es in the private sector indicate that this seems to be the case.

The size of the available S&E employment pool in the U.S. work force cannot be stated with certainty, but it has been reported that upwards of 50 percent of those earning B.S. degrees in S&E-related fields transfer out of the S&E field.[3,4] This loss of available talent was perhaps most evident during the downturn in aerospace industry employment during the 1970s. More recently, events in eastern Europe have led to speculation that a reduction in the funding of military programs will lead to the greater availability of experienced S&Es from the military side of the aerospace industry. However, this merely represents an additional factor in an already uncertain equation.

The availability of new S&Es is not expected to improve in the near future — forecasts are that there will be an increase in the demand for engineers through the 1990s, while the supply will be decreasing, primarily as a result of the busted baby boom reducing the size of the traditional pool of students entering S&E fields.[5,6] The issue of attracting students to S&E fields, a "pipeline" issue, will not be addressed here.

An additional source of experienced S&Es that should not be overlooked are recent retirees. These experienced retirees can be utilized through support service contractors or as private consultants when comparable, but unavailable, S&Es are needed. The 1989 enactment of Public Law 100-679 (Post Employment Restriction Act) placed restrictions on post-employment activities for former federal procurement officials and resulted in accelerating the retirement of some employees, but any long-term effect on retirement statistics is likely to be negligible. Further complicating this situation was the recent suspension of PL 100-679 by Congress until December 1, 1990.

Although contentious, the use of retirees via support service contracts or as private consultants is particularly appealing when personnel funding (R&PM) is limited, but contracting funds (R&D) are available. Such an effort, however, should not detract from the development of an in-house technical workforce. In essence, it only serves to postpone the inevitable transition of experience.

Regardless of the success of our efforts to hire experienced S&Es from outside NASA, we must ensure that we do not neglect the development of the in-house pool of talent that is already available.

Increase Awareness

One of the easiest ways to deal with an issue is to heighten awareness of the issue among the people most affected. This is possible, for example, through articles (such as this one) in employee newsletters and technical publications, and in briefings to the technical workforce (particularly as part of orientation and retirement seminars). The personnel who comprise the technical work force will determine the future viability of NASA. If the issue is credible and gains grassroots acceptance, then individual actions addressing the issue will become a matter of routine rather than a result of formal policy. For example, the Equal Employment Opportunity (EEO) Office at NASA Goddard Space Flight Center, Greenbelt, MD, has provided first-line supervisors with the opportunity to attend a one-day, in-house training program on "Managing Age Diversity."

Support Employee Development Programs

While we may be limited in our ability to hire additional S&Es, we can and should continue to support programs that provide employees with opportunities to develop greater technical or managerial experience. These programs constitute an investment by the agency in its future that requires commitment at all levels of management. A critical element to the success of these programs is the support of first-line management. These are the managers who are in the trenches and who must balance the long-term developmental needs of their employees (in the interest of the employee and the agency) with the near-term demands of the group activities (in the interest of the tasks at hand).

Most obvious among these programs are the continuing and graduate education programs that enable NASA employees to pursue degrees of higher education during their employment or to enhance their technical education. Less obvious, perhaps, is the "continuing education" that occurs when employees attend professional and technical meetings where information is shared and valuable contacts are made throughout the industry. Such activities may be viewed as a form of "continuing education" for experienced employees, insofar as the activity enhances their ability to succeed on the job.

Other NASA programs provide for non-academic personnel development. NASA's Professional Development Program (PDP), for example, allows selected NASA personnel to participate in a one-year developmental program at NASA Headquarters or a NASA Center. The program is intended to provide the opportunity for individuals to broaden their technical and programmatic experience, as well as to gain an understanding and appreciation of the culture and perspective of other organizational elements within NASA. More emphasis on inter- and intra-Center assignments should also be considered.

Document and Disseminate Information

Valuable information can be lost if adequate and timely documentation of technical and

managerial information does not occur.[7] All too often, formal documentation does not occur until a program or project is either cancelled or completed, and "lessons learned" become "lessons lost" as key employees move on to other assignments and personal files are either discarded or sent into storage.[8]

Policies should be established and promoted, particularly by relevant program and project managers, that facilitate the documentation and dissemination of technical and management information. In the case of detailed, technical design data, it will also be necessary to provide updates to the information base as new or revised information becomes available.

In general, this activity will necessarily involve the efficient and widespread storage and dissemination of information via electronic media. On a more immediate level, the mass of documentation associated with major programs, such as Space Station Freedom, is too extensive for any individual to be familiar with the bulk of it.

Establish Deputy Manager Positions

Nothing provides better experience than on-the-job training and experience. One possibility for accelerating the management "education" of inexperienced employees would entail the official or unofficial establishment and promotion of temporary or rotating positions for deputies to first-line managers. These positions would provide management experience for qualified employees, while minimizing the risks associated with placing an untrained individual in an unfamiliar, and perhaps, in appropriate role. The non-permanent nature of the position would avoid the appearance of a demotion when the individuals return to their former position, while maximizing the number of employees who could benefit from the experience. Caution should nonetheless be exercised to ensure that such positions do not generate an undesirable, and possibly unnecessary, layer of bureaucracy.

Establish Chief Engineer/Scientist Positions

Within programs and areas of technical expertise, it is advantageous to the organization to maximize the benefits available through the experience of senior individuals. This organizational need can be balanced by the benefit accrued to the senior employee who has either stagnated on the technical side of the dual-career ladder, or who chooses to relinquish supervisory responsibilities in favor of a more technical, non-supervisory role. Ideally, this is the situation encountered in establishing positions for chief scientists and chief engineers. These positions would enable a greater number of individuals to benefit from experienced, non-supervisory S&Es, while providing highly-valued S&Es with greater visibility and enhanced recognition of their value to both the group and the agency.

Implement Technical Mentor Programs

Although established fresh-out mentoring programs exist at several NASA Centers, there does not appear to be an agency-wide position on mentoring. In some respects, each program must necessarily be tailored to the personality and culture of the particular Center; however, there should be some program characteristics that are common among mentoring programs at all the Centers. An example of a Center initiative is the Interactive Development of Engineers, Administrators, and Scientists (IDEAS) program, at NASA Ames Research Center (ARC), Mountain View, CA, designed to better integrate new hires into the ARC work force through interaction with peers and highly regarded senior employees. Participant feedback has shown that the long-time employees involved in the program claim a feeling of revitalization as a result of their experiences within the program.

It is not enough to place an inexperienced individual in a position of responsibility, par-

ticularly on long-term programs, when hardware will not be produced for some time. A pratical understanding of technical principles is necessary if success is to be ensured.

We can serve two purposes by facilitating interactions among experienced, long-time employees, and inexperienced fresh-outs or new-hires — the new employees are more quickly schooled in the culture and history of the organization, and technical insight and knowledge can be passed along; and the long-time employees are presented with fresh, new perspectives that sometimes break with accepted lines of thinking. These interactions could take the form of one-on-one pairings that provide both technical and cultural mentoring, or they could take the form of small, low-cost, low-risk technical projects that provide inexperienced personnel with the opportunity to acquire invaluable hands-on experience.

Conclusions: What the Age Distribution Issue Means to NASA Management

The challenge of balancing short-term needs (i.e., utilizing existing experience to meet current demands) and long-term needs (i.e., developing new talent to meet projected demands) has increased for the NASA manager due to the combination of a large number of experienced S&Es nearing retirement age, a dearth of mid-career S&Es, and a large cadre of relatively inexperienced S&Es.

The character of the agency will certainly change in the near future as the average age and experience levels of our S&Es decrease. As we strive to fulfill the requirements of new and existing missions, we can prepare our less-experienced S&Es to assume greater levels of technical and managerial responsibility at an earlier age. The resources that we have at our disposal will be best directed in areas over which we are able to exert the most control, such as the development of in-house talent.

The future promises both challenges and opportunities for the NASA manager. While we may hope for the best, we should nonetheless plan for the future in order to assure the continuity needed for increasingly complex missions.

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