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# AGE DISTRIBUTION AMONG NASA SCIENTISTS AND ENGINEERS

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## ABSTRACT

The loss of technical expertise through attrition in the technical workforce is a growing concern throughout NASA and the aerospace industry. A bimodal age distribution among scientists and engineers (S&Es) exacerbates the situation within NASA. This situation presents both challenges and opportunities to NASA managers as decisions are made that will shape the future of NASA.

This paper will document historical age-related information for S&Es within NASA in general, and at the NASA Lewis Research Center, Cleveland, Ohio, in particular, for 1968 through 1987. Recommendations are made to promote discussion and to establish the groundwork for action.

## INTRODUCTION

The technical competence and reputation of an organization is based on the competence of the individuals who comprise the technical workforce. In this context, the technical workforce contains both supervisory and nonsupervisory scientists and engineers (S&Es). These individuals form the core of institutional technical memory which is the marketable commodity of an organization.

Imagine an organization in which all the technical personnel are replaced with inexperienced personnel. The organization would certainly suffer since the commodity they offer, technical experience, has been eliminated. Conversely, an organization that exhibits a uniform distribution of experience among its technical personnel is less likely to suffer significantly as a result of the loss of their most experienced personnel, since only slightly less experienced personnel would be waiting to fill the vacancies.

A bimodal age distribution, i.e., with two distinct peaks or modes, may preclude a smooth personnel transition. Experienced senior S&Es will be replaced with relatively inexperienced junior S&Es rather than with midlevel S&Es, since few are available. Age (i.e., length of NASA service) and experience are highly correlated characteristics among NASA S&Es, contributing to their low attrition rate. Because of this correlation, institutional technical expertise is a strong function of the age distribution among the technical workforce. A detailed discussion of factors that resulted in the age distributions presented is beyond the scope of this paper.

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Early in the U.S. civilian space program, after the formation of NASA in 1958, many S&Es were hired directly from the collegiate ranks. These inexperienced, but enthusiastic, graduates acquired valuable experience as they matured along with the Mercury, Gemini, and Apollo programs.

In the late 1960s, forces external to NASA (e.g., Congress, OMB, the national budget, and others) dictated a decrease in the size of the NASA workforce, and a corresponding decrease in the number of S&Es. Figures 1 and 2 show, however, that even as the size of the total NASA workforce and the S&E population decreased, the percentage of S&Es increased (from 43 percent in 1968 to 51 percent in 1987).

The issue of technology loss through attrition must be addressed now. 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 in 1991, since they will have at least 30 years of service and will be 55 years of age. Valuable institutional technical knowledge and experience will be lost when these employees retire.

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 representative of the aerospace industry in general. The size of the available S&E manpower pool in the U.S. workforce 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 [1,2].

## DATA

The following information was obtained from raw data and summary reports prepared by the NASA Personnel Evaluation and Analysis Division for the years 1968 through 1987 [3]. S&Es are defined by the following NASA positions:

### Support Engineering and Related Positions

This includes professional physical science, engineering, and mathematician positions in work situations not identified with aerospace technology.

### Aerospace Technology (AST) Scientific and Engineering Positions

This includes 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

This includes life science professional positions not requiring AST qualifications, and medical officers and other positions performing

professional work in psychology, the biological sciences, and professions which support the science of medicine such as nursing and medical technology.

Table 1 presents the historical NASA S&E age data for 1968 through 1987. The age data has been categorized in the following age groups: less than 25 years of age, 25 to 29 years, 30 to 34 years, 35 to 39 years, 40 to 44 years, 45 to 49 years, 50 to 54 years, 55 to 59 years, and 60 years of age or more.

Figure 3 illustrates that the NASA S&E population has been aging along with NASA. The peak age-group shifted from 30 to 34 years of age in 1968, to 40 to 44 years in 1978, and to 50 to 54 years in 1987. A smaller, secondary age-group peak (25 to 29 years) appears on the 1987 curve as a result of an influx of new employees, primarily recent graduates. The magnitude of the primary age-group peak decreases only slightly between 1968 to 1987, once again contributing to the relatively low attrition rate among NASA S&Es, during that time as the age distribution shifts from a skewed normal to a bimodal age distribution.

Figure 4 contains the same information shown in Figure 3, but with the number of S&Es in each age group shown as a percentage of the total number of NASA S&Es. Since 1968, 19 to 23 percent of the total S&E population has consistently been concentrated in the peak age group.

Figure 5 further illustrates the aging of the NASA S&E population. The percentage of S&Es in the 35 to 49 age group has steadily decreased since 1970, while the percentage of S&Es in the over-50 age group has steadily increased (although at a slightly lower rate of increase than the rate at which the percentage in the 30 to 49 age group decreased). In addition, the decreasing trend in the percentage of S&Es in the under-35 age group was reversed about 1980.

The NASA Lewis data represents a microcosm of NASA's S&E trends. Table 2 presents the historical NASA Lewis S&E data for 1968 through 1987, during which NASA Lewis S&Es constituted 10 to 13 percent of NASA's S&E workforce. Figures 6 to 8 present NASA Lewis S&E data, comparable to the NASA S&E data presented in Figures 3 to 5.

Figure 9 illustrates that NASA's aging trend stabilized about 1979, and was effectively reversed about 1984, primarily as a result of the infusion of S&E new-hires and the inevitable loss of senior S&Es. The average age of NASA S&Es increased at a rate of 0.65 years per year between 1968 and 1978. Among NASA Lewis S&Es, the rate was a comparable 0.68 years per year.

## RECOMMENDATIONS

The following is a list of recommendations which, although not comprehensive, attempts to promote discussion and to establish the groundwork for action. It includes measures that are extensions of or variations on existing NASA initiatives.

Contractors/Consultants

Continue to use experienced S&E retirees through Support Service Contractors or as private consultants when comparable, but unavailable, S&Es are needed. This measure is particularly appealing when manpower 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.

Technical Mentor Programs

Establish and formally implement technical mentor programs that pair technical new-hires with experienced S&Es. Variations exist within some NASA organizational elements. For example, the NASA Ames Research Center (ARC) has introduced a new training program known as the Interactive Development of Engineers, Administrators, and Scientists (IDEAS) program. This program was specifically designed to counter the loss of institutional knowledge and experience arising from a bimodal age distribution in their S&E workforce.

Documentation

Establish and promote a policy or policies that formally encourage or require documentation during the life of projects and programs. Valuable information is lost to NASA when adequate documentation does not occur until a program/project is either cancelled or completed. By then, it is often too late as personnel move on to other work or are not provided with the proper incentive to document their work. The feasibility of implementing such policy is enhanced by the existence of electronic storage media and telecommunications. As an example, the Space Station Technical and Management Information System (TMIS) is planned to serve as the knowledge base of information for the U.S. space station program, precluding the loss of key information resident in specific individuals.

Employee Development Programs

Continue to promote programs that provide junior and midlevel S&Es with development opportunities for greater technical and/or managerial experience. These S&Es are likely to increase the pool of manpower that will be available to fill the roles vacated by senior S&Es. An example is NASA's Professional Development Program (PDP). The PDP allows selected NASA professional personnel to participate in a one year developmental program at NASA Headquarters and/or at a different NASA Center. Such a program broadens the individual's technical and organizational experience.

Awareness Programs

Increase the dissemination of information on relevant issues through presentations and articles in technical and nontechnical forums, e.g., the Aerospace Mechanisms Symposium, employee newsletters, and technical journals.

### Chief Engineer/Scientist Positions

Promote positions for Chief Engineers/Scientists who report directly to the midlevel (second- or third-level) manager. Such positions enable a greater number of individuals to benefit from the experience of senior, nonsupervisory S&Es.

### Deputy Manager Positions

Establish and promote positions for deputies to first-level managers that allow junior S&Es to gain managerial experience on a probationary or rotating basis. These positions provide work experience while minimizing the risks associated with submerging an untrained individual in an unfamiliar role. Caution should be exercised to ensure that such positions do not generate an undesirable, and possibly unnecessary, level of bureaucracy.

### Hire Experienced S&Es

Efforts should be continued to attract experienced S&Es. As mentioned previously, the size of the pool of available experienced S&Es is an open question. S&Es are in demand now, but many may have made career changes in the 1970s. These changes are a result of factors such as the lucrative offers being made to the MBA candidates with technical backgrounds, as well as the downturn in employment opportunities in the aerospace and energy-related fields. However, as with the use of experienced S&E retirees, such efforts should not detract from the development of the existing in-house technical workforce.

## ACKNOWLEDGMENTS

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## REFERENCES

1. "The Science and Engineering Talent Pool." Proceedings of the 1984 Joint Meeting of the Scientific Manpower Commission and the Engineering Manpower Commission, National Academy of Sciences, Washington, D.C., May 15, 1984.

2. "The Technological Marketplace - Supply and Demand for Scientists and Engineers." Scientific Manpower Commission, May 1985.

3. Personnel Management Information System (PMIS) Reports from NASA Headquarters Personnel Programs Division, Washington, D.C.

TABLE 1. AGE DISTRIBUTION AMONG NASA SCIENTISTS AND ENGINEERS

| Year | Age range | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-25 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | ≥60 | |
| 1968 | 633 | 2168 | 2945 | 2767 | 2136 | 1874 | 815 | 347 | 166 | 13 851 |
| 1969 | 459 | 1946 | 2849 | 2829 | 2150 | 2097 | 900 | 406 | 203 | 13 839 |
| 1970 | 381 | 1718 | 2658 | 2914 | 2235 | 2167 | 1085 | 472 | 207 | 13 837 |
| 1971 | 286 | 1396 | 2435 | 2837 | 2243 | 2103 | 1248 | 477 | 202 | 13 227 |
| 1972 | 135 | 1109 | 2185 | 2746 | 2383 | 1950 | 1452 | 453 | 203 | 12 616 |
| 1973 | 89 | 801 | 2000 | 2594 | 2517 | 1900 | 1559 | 467 | 158 | 12 085 |
| 1974 | 108 | 606 | 1769 | 2524 | 2541 | 1888 | 1684 | 486 | 164 | 11 770 |
| 1975 | 153 | 521 | 1537 | 2408 | 2608 | 1962 | 1701 | 594 | 181 | 11 665 |
| 1976 | 186 | 468 | 1308 | 2264 | 2662 | 2050 | 1738 | 736 | 200 | 11 612 |
| 1977 | 167 | 456 | 1063 | 2072 | 2574 | 2314 | 1685 | 974 | 239 | 11 544 |
| 1978 | 176 | 503 | 874 | 1928 | 2528 | 2406 | 1683 | 1098 | 269 | 11 465 |
| 1979 | 199 | 503 | 728 | 1744 | 2475 | 2482 | 1671 | 1175 | 314 | 11 291 |
| 1980 | 349 | 598 | 725 | 1544 | 2379 | 2562 | 1733 | 977 | 333 | 11 200 |
| 1981 | 317 | 666 | 725 | 1343 | 2212 | 2551 | 1772 | 952 | 385 | 10 923 |
| 1982 | 328 | 710 | 660 | 1159 | 2060 | 2475 | 1927 | 966 | 461 | 10 746 |
| 1983 | 602 | 809 | 709 | 958 | 1940 | 2454 | 2049 | 1034 | 539 | 11 094 |
| 1984 | 557 | 909 | 706 | 842 | 1723 | 2379 | 2091 | 1074 | 598 | 10 879 |
| 1985 | 636 | 1168 | 781 | 837 | 1508 | 2269 | 2171 | 1137 | 637 | 11 144 |
| 1986 | 549 | 1375 | 887 | 862 | 1327 | 2120 | 2207 | 1183 | 637 | 11 147 |
| 1987 | 627 | 1612 | 1055 | 916 | 1229 | 2044 | 2206 | 1307 | 683 | 11 679 |

TABLE 2. AGE DISTRIBUTION AMONG NASA LEWIS SCIENTISTS AND ENGINEERS

| Year | Age range | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-24 | 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 | 1812 |
| 1969 | 35 | 233 | 321 | 342 | 294 | 326 | 138 | 57 | 32 | 1778 |
| [a]1970 | 27 | 194 | 312 | 331 | 302 | 329 | 170 | 66 | 28 | 1757 |
| 1971 | 19 | 154 | 302 | 320 | 309 | 332 | 202 | 75 | 23 | 1736 |
| 1972 | 12 | 102 | 271 | 306 | 308 | 287 | 238 | 73 | 31 | 1628 |
| 1973 | 6 | 66 | 223 | 265 | 300 | 260 | 249 | 67 | 22 | 1458 |
| 1974 | 5 | 43 | 188 | 256 | 286 | 245 | 245 | 73 | 22 | 1363 |
| 1975 | 6 | 38 | 153 | 254 | 271 | 265 | 242 | 89 | 25 | 1343 |
| 1976 | 18 | 34 | 111 | 244 | 270 | 262 | 250 | 128 | 31 | 1348 |
| 1977 | 25 | 36 | 90 | 230 | 260 | 268 | 240 | 158 | 32 | 1339 |
| 1978 | 28 | 40 | 64 | 209 | 253 | 276 | 228 | 173 | 43 | 1314 |
| 1979 | 29 | 42 | 58 | 177 | 247 | 285 | 220 | 197 | 47 | 1302 |
| 1980 | 27 | 50 | 57 | 141 | 251 | 266 | 244 | 155 | 47 | 1238 |
| 1981 | 19 | 59 | 52 | 116 | 240 | 253 | 226 | 157 | 61 | 1183 |
| 1982 | 33 | 66 | 49 | 96 | 226 | 239 | 212 | 151 | 72 | 1144 |
| 1983 | 133 | 98 | 80 | 73 | 213 | 236 | 227 | 148 | 88 | 1296 |
| 1984 | 122 | 112 | 79 | 64 | 180 | 240 | 233 | 156 | 91 | 1277 |
| 1985 | 114 | 176 | 87 | 74 | 146 | 247 | 226 | 173 | 94 | 1337 |
| 1986 | 46 | 218 | 92 | 75 | 122 | 231 | 230 | 161 | 104 | 1279 |
| 1987 | 56 | 249 | 127 | 92 | 108 | 228 | 229 | 164 | 120 | 1373 |

[a]Figures for 1970 were obtained through interpolation of the data from 1969 and 1971.

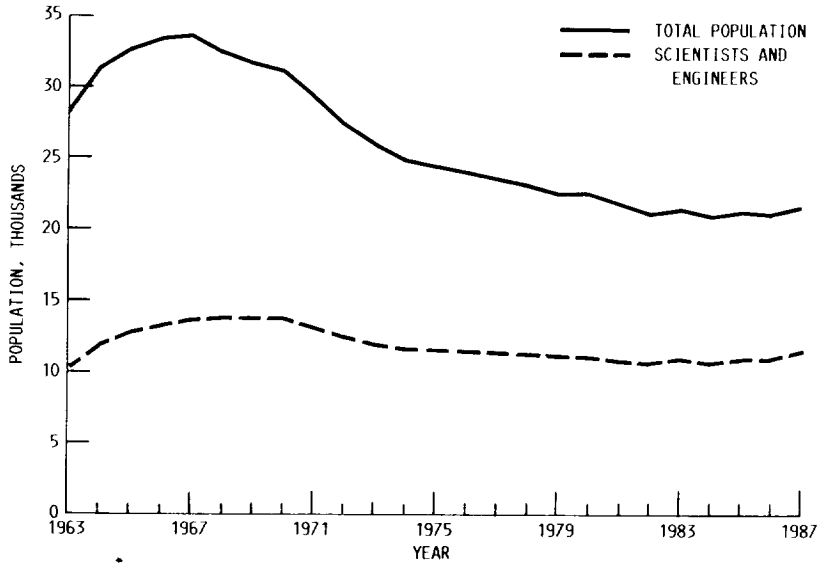


Figure 1. NASA Civil Service population.

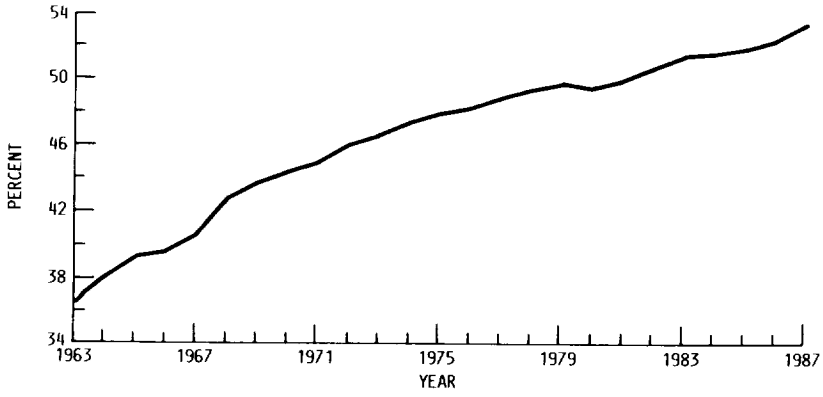


Figure 2. S&Es as a percent of the total NASA Civil Service population.

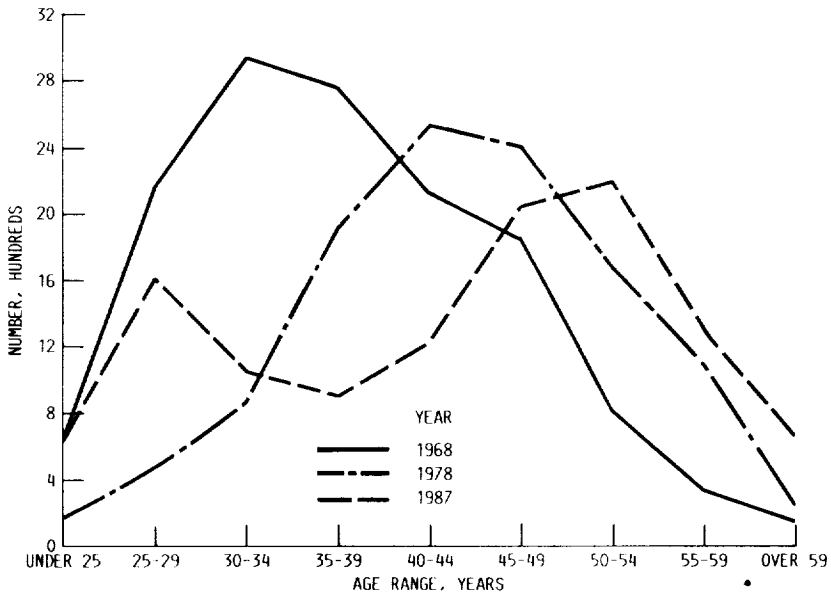


Figure 3. Age distribution among NASA S&Es (number).

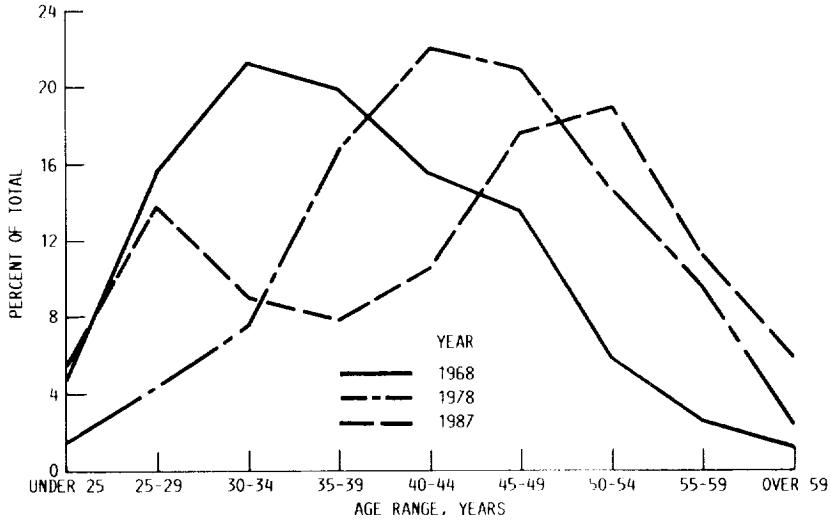


Figure 4. Age distribution among NASA S&Es (percent).

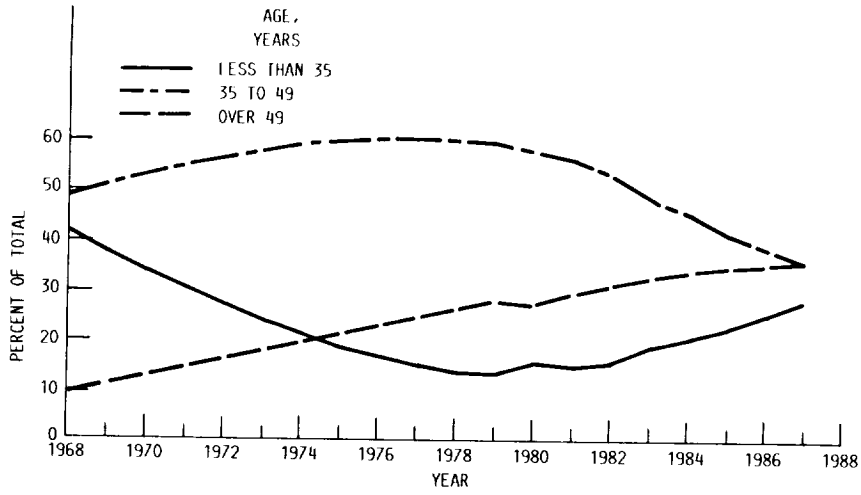


Figure 5. Percent of NASA S&Es in given age ranges.

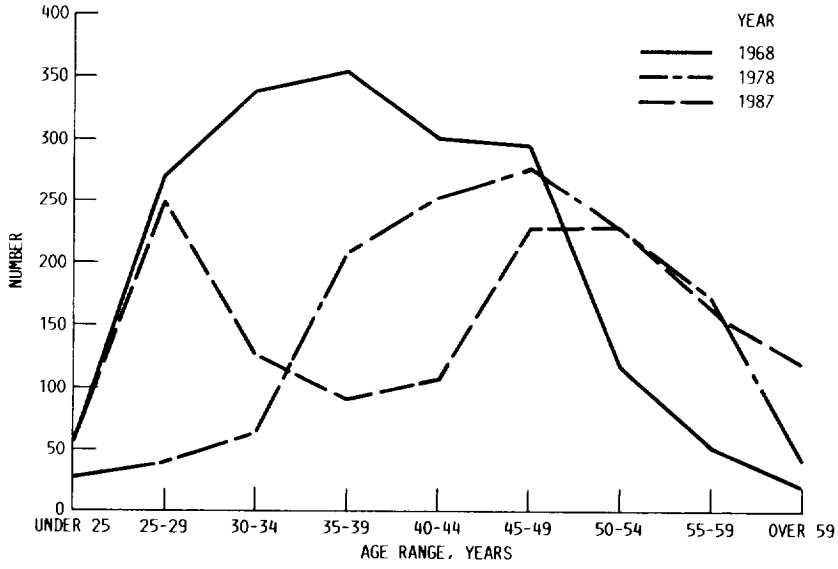


Figure 6. Age distribution among LeRC S&Es (number).

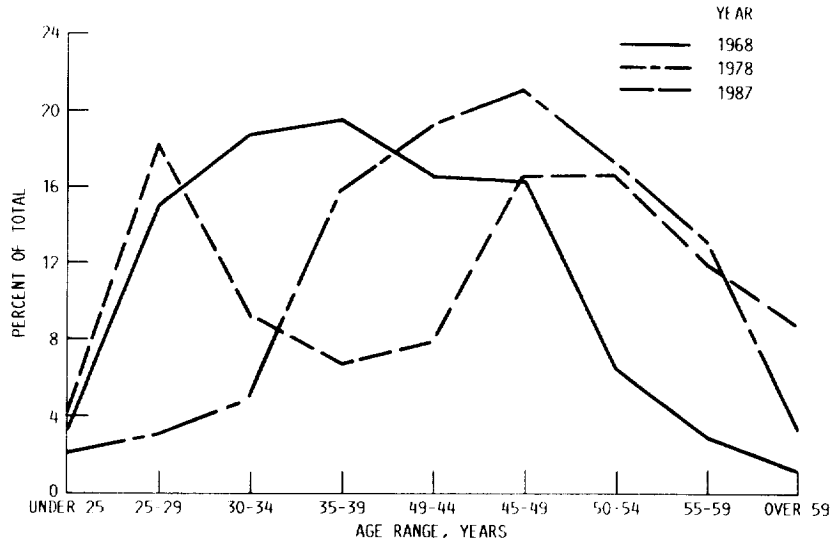


Figure 7. Age distribution among LeRC S&Es (percent).

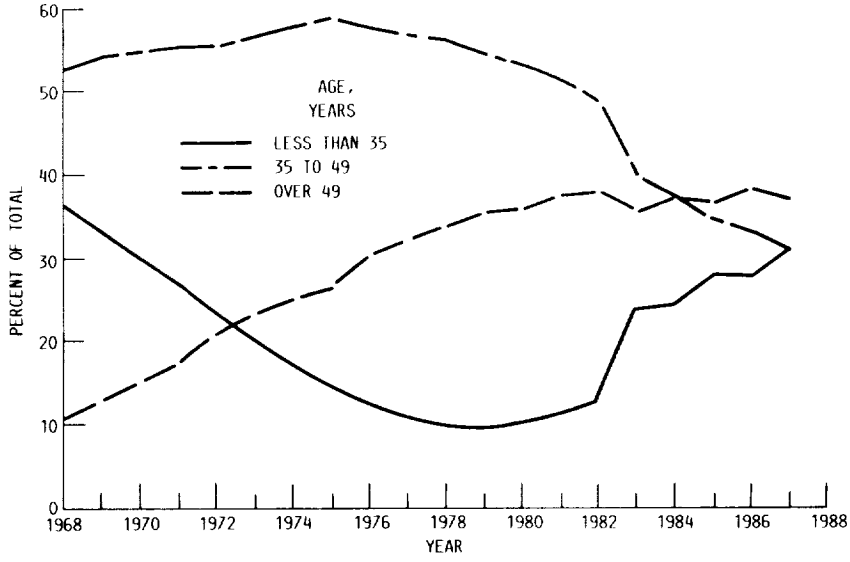


Figure 8. Percent of LeRC S&Es in given age ranges.

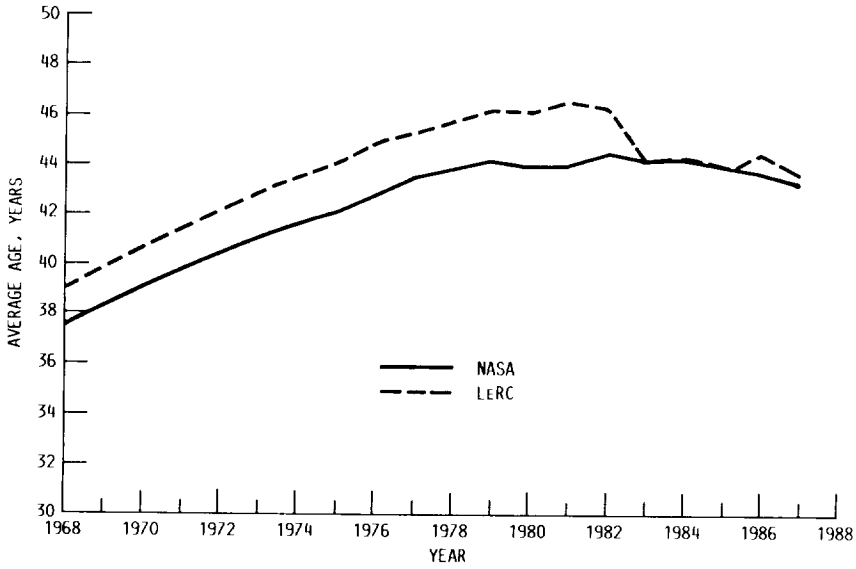


Figure 9. Average age of NASA and LeRC S&Es.