OPERATIONAL TESTING OF A FIGURE OF MERIT FOR OVERALL TASK PERFORMANCE

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An overall indicator, or figure of merit (FOM), for the quality of pilot performance is needed to define "optimal" workload levels, predict system failure, measure the impact of new automation in the cockpit, and define the relative contributions of subtasks to overall task performance. A normative FOM has been developed (ref. 1) based on the calculation of a standard score for each component of a complex task. It reflected some effects, detailed in an earlier study (ref. 2), of the introduction of new data link technology into the cockpit. Since the technique showed promise, further testing was done this summer.

A new set of data was obtained using the recently developed Multi-Attribute Task Battery (ref. 3). This is a complex battery consisting of four tasks which can be varied in task demand, and on which performance measures can be obtained. It is illustrated in Table 1.

Table 1. Tasks in the Multi-Attribute Task Battery, with methods of controlling task demand and performance measures.

Task	Description	Demand Control	Performance measure
Monitoring	changes in lights and dials	events per minute	response time to event onset
Tracking	2-dimensional, first order compensatory task	frequency of generating function	RMS error
Communications	responses to verbal messages	events per minute	response time to event onset
Resource Management	adjusting fuel level in 6 tanks with 8 pumps	ratio of pump flow rates	RMS error from 2500 gals

This battery was presented to 12 subjects in a 20 minute trial at each of three levels of workload or task demand, and performance measures collected on all four tasks. The NASA-TLX workload rating scale was presented at minutes 6, 12, and 18 of each trial. A figure of merit was then obtained for each run of the battery by calculating a mean, SD, and standard score (number of SD units away from the mean) for each task. This procedure, with its rationale, is described in more detail in reference 1.

The resulting figure of merit increased significantly with increasing workload and was also positively correlated with error rate in the monitoring task, so that, when the FOM indicated poorer performance, missed signals were also more likely.

Each task contributed its own proportion to the overall FOM, and relative contributions changed with increasing workload. Figure 1 shows decreases in performance on tracking and resource management, but not on communications and monitoring, when workload

increases. Figure 2 shows the increase in resources that had to be devoted to communications and monitoring in order to maintain that constant performance, and that this was at the expense of performance on tracking and resource management. Thus, the FOM shows the effect of task changes, not only on the individual task that is changed (e.g. obviated by automation or greatly increased by a near accident), but also on the performance of other tasks and of the whole task. The cost to other tasks of maintaining constant performance on an individual task can be quantified.

The ratings collected later in the task got lower under low workload and higher under high workload, i.e., easy tasks got easier with time, while hard tasks got harder.

References

1. LeMay, M.K. & Comstock, J.R. (1990) A normative figure of merit for the quality of overall task performance. Proceedings of the Human Factors Society, 34th Annual Meeting, October, 1990: Orlando, FL.

2. Waller, M.C. & Lohr, G.W. A Piloted Simulation Study of Data Link ATC Message Exchange. NASA TP-2859.

3. Comstock, J. R. & Arnegard, R.J. (1990) Multi-Attribute Task Battery. NASA Langley Research Center TM (in review).

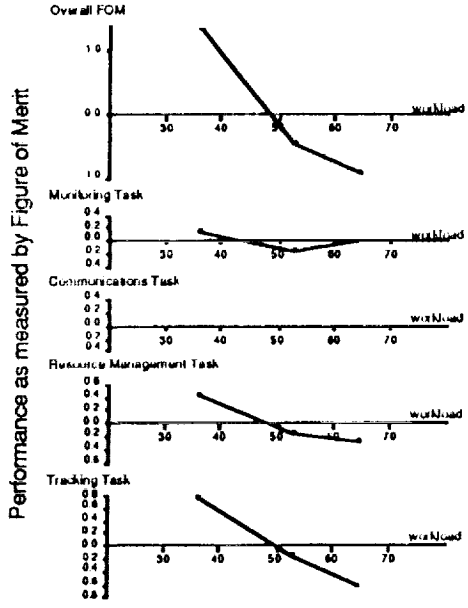

Figure 1. Whole task and subtask performance at three workload levels

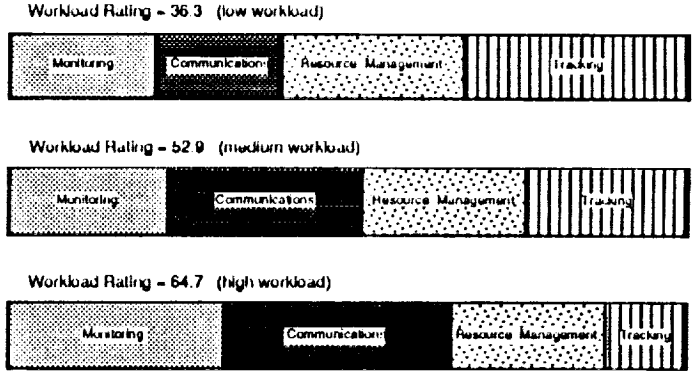

Figure 2. Proportion of cognitive resources used by four time-shared tasks under three workload levels

SURVEY OF LANGLEY AEROSPACE RESEARCH SUMMER SCHOLARS (LARSS)

by

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Abstract

While Director of the 1990 LARSS program, I designed a Survey for Langley Aerospace Summer Scholars. The main purposes of the survey were to track those students who participated in LARSS. The objectives included tracking those continuing their education, and those permanently employed in industry, government, and higher education, and creating a database for future tracking.

One of the most significant results is that there are currently 26 past LARSS graduates currently employed by NASA or NASA Contractors.

Of the responses, 62% indicate that they are continuing their education with 65% enrolled in graduate programs and 35% enrolled in undergraduate programs. Of these, 22% are pursuing doctoral degrees, 43% are pursuing masters, and 35% are bachelor level students.

It is also significant that 49% of those permanently employed are working for the government or a federal research laboratory; 47% are working in industry, and 5% are working in higher education. Eighty-one per cent of those working for the government are NASA employees or NASA Contractor employees.

The following is a synopsis of the data obtained from the responses:

Topic	# Responses	Percentage
Surveys Sent	197	
Surveys Returned	134	68%
Graduates Continuing Education	83	62%
Bachelor Level Students	29	35%
Master Level Students	36	43%
Doctoral Level Students	18	22%

Graduates Employed Full Time:	66		49%
Government Employees		32	49%
Industry Employees		31	47%
Higher Education Employees		3	4%
NASA Employees or NASA Contractors		26	78%

NASA employment opportunities:

Graduates Interested	102	76%

Income Versus Degree (Median Range):

NASA/NASA Contractors	
Bachelor's Degree	$25,001-$30,000
Master's Degree	$30,001-$35,000
Industry, Government, Higher Education Employees (NOT NASA/NASA Contractors)	
Bachelor's Degree	$30,001-$35,000
Master's Degree	$35,001-$40,000

This analysis reflects the growth in the quality of the Langley Aerospace Summer Scholars Program. The program continues to expand and these students are providing an excellent pool of qualified candidates for NASA recruitment. Seventy-six percent of the respondents indicated they were interested in learning more about career opportunities at NASA.

References: Dr. Samuel E. Massenberg, University Affairs Officer
Sherry Sullivan, NASA Langley Personnel Division
Past LARSS Graduate Rosters

SURVEY OF LANGLEY AEROSPACE RESEARCH SUMMER SCHOLARS

(Please print or type)

1. NAME _____ 2. LARSS 1986 1987 1988 1989 1990 (circle)

   Cross Reference: Maiden name or former name legally changed _____

3. Permanent Address: _____

4. Mailing Address _____

5. Daytime Phone Number: ( )_____ 6. Birthdate: _____
   Mo/Day/Year

7. Social Security Nunber: _____ - ____ - _____ 8. Sex: [] F [] M

9. Marital Status: [] Married [] Single (including divorced, widowed)

10. Ethnic Background:
    [] Native American [] Caucasian [] Hispanic
    [] African American [] Asian [] Other

EDUCATION

11. University or College Currently Attending:

Institution	Grade Point Average	Completion Date	Degree/Program

12. Status: [] Undergraduate [] Graduate [] Postgraduate

13. Attending: [] Day [] Evening [] Full time [] Part time

14. Highest Degree Earned:

Institution	Grade Point Average	Completion Date	Degree/Program

EMPLOYMENT

15. Current Status:
    [] Am presently employed by _____ Position _____
    Organization /Address
    [] Have signed contract or made a commitment with _____
    [] Am seeking employment
    [] Am negotiating with one or more specific organizations
    [] Other (specify) _____

16. Current Annual Income:
    [] $20,000 or less [] $35,001 - $40,000
    [] $20,001 - $25,000 [] $40,001 - $45,000
    [] $25,001 - $30,000 [] $45,001 - $50,000
    [] $30,001 - $35,000 [] $50,000 or more

17. Are you interested in learning more about career opportunities with NASA? [] Yes [] No

18. Other noteworthy achievements you would like to include: _____

19. How did the LARSS experience influence you? _____

Signature _____ Date _____