NBSIR 88-3827

Evaluation of the Working Environment at Selected US Army Field Stations: Suggestions for Improvement

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U.S. DEPARTMENT OF COMMERCE, C. William Verity, *Secretary*
NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

Abstract

In response to concerns expressed by headquarters INSCOM, a detailed evaluation of environmental conditions in U.S. Army field stations was undertaken. In the present report, findings and recommendations are given based on interviews with station personnel, questionnaire responses from over 600 people in three job types (operator, analyst, and administrative/other), extensive measurements of physical conditions, and careful observations of a host of representative activities. Three field stations were evaluated: Kunia, Augsburg, and Berlin in 1987. The findings confirm the concerns expressed by headquarters INSCOM; namely, field station personnel perform their jobs under conditions likely to impair their effectiveness. These include poor thermal, lighting, and acoustic conditions, as well as furnishings such as chairs and desks in very poor repair, equipment that is dysfunctional, and general lack of regular maintenance in the facilities. Suggestions for improving conditions in the facilities are presented.

Keywords: Environmental assessment, comfort, glare, lighting, noise, post-occupancy evaluation, temperature, VDT's.

Foreword

This report is the second in a series of reports by the National Bureau of Standards on the evaluation of conditions in U.S. Army field stations. It was supported by the U.S. Army Intelligence and Security Command (USAINSCOM) under contract No. A73050-0134-87 from August 1986 to July 1988. Field evaluations were conducted at Kunia in December 1986 and April 1988 and at Berlin and Augsburg in June - July, 1987.

Acknowledgements

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Executive Summary

The present research project was initiated in response to a concern expressed by members of headquarters INSCOM that field station personnel worked under conditions that had adverse consequences on their performance and personal well being. The intent of the study was to gain an understanding of the factors that combine to adversely influence field station personnel, and recommend ways to alleviate problems. The primary factors believed to be relevant were environmental conditions (lighting, acoustics, thermal comfort), human factors (man-machine interfaces), furnishings, job design and shift work.

The present report presents findings and recommendations based on interviews with station personnel, questionnaire responses from over 600 people in three job types (operator, analyst, and administrative/other), extensive measurements of physical conditions, and careful observations of a host of representative activities. Three field stations were evaluated: Kunia, Augsburg, and Berlin. The findings confirm the concerns expressed by headquarters INSCOM; field station personnel perform their jobs under conditions likely to impair their effectiveness. These include poor thermal and lighting conditions, as well as furnishings in very poor condition, dysfunctional equipment, and general lack of maintenance in the facilities.

Specific results from the questionnaire indicated that more than 50% of all respondents consider their work to be very important. The data also indicate that more than 50% of all respondents consider that their work must be very accurate. Although a majority of respondents consider that their jobs are at least somewhat satisfying (with analysts among the most satisfied), about 30-35% of the operators consider that their job is not very satisfying.

In terms of specific environmental conditions, temperature emerged as a major problem area with the Berlin and Augsburg field stations seen as too cold, particularly in the operational areas, while in the analytic areas there were problems with stuffiness and poor air quality. Lighting was another major problem area, with the majority of people at all sites rating their ability to adjust light as very poor, with 70% of analysts being particularly negative. Physical measurements confirmed the presence of wide swings in temperature and air flow rates, as well as low lighting levels for some tasks and excessive glare on computer screens.

The overall appearance of the workspaces created problems as well, with a majority of respondents believing that the overall appearance of their workspaces was only fair to poor. In addition, analysts, particularly those in Kunia, felt that their work area was especially confined. In fact, less than 20% of any group rated their area as spacious. People found their workspaces to be unstimulating and tense, and drab rather than colorful. Most respondents missed having a view out, and expressed a desire to know about the weather outside or be able to take a break outside. All respondents felt that people overhearing their conversations was a problem, with more than 80% of the analysts in Kunia

finding this statement to be very true. Similarly, the majority of the respondents found their visual privacy to be poor to fair, with limited amount of space for personal items.

Although some groups felt the amount of surface area for work was especially poor, more than 70% of all analysts and operators rated surface area as only fair. Lack of room to spread out paper tasks was very bothersome for many analysts, with 60 to 70% of all analysts considering their furniture condition to be fair to poor. The ability to adjust the back of the chair was seen as a problem by most respondents, with chair condition emerging as a major problem in operational areas due to their non-stop use.

As many as 50-70% of those questioned reported having frequent headaches and being sleepy sometimes or always. In fact, 30 to 40% of the operators indicated that they were always sleepy, while another 40% were sometimes. Eye irritation was also a problem for 40% to 60% of the sample.

When people were asked what changes they would make to their space, the most desired changes at both Berlin and Augsburg was a better year round temperature. At Kunia, the first choice of the administrators was improved air circulation, that for the operators was access to the outside, and that for the analysts was privacy.

At all field stations, a number of potential contributors to stress were observed. These included environmental conditions such as overall appearance, cold temperatures, inadequate lighting, constant noise, lack of privacy and absence of view out or ability to go outside during the day. Another series of stressors was provided by the furnishings which included broken chairs; old and broken desks; lack of storage space; and worn and tattered carpets. For each field station as a whole, problems were seen with inadequate break areas and places to unwind, non-existent conference rooms, and no training areas.

Other situations that created unnecessary stress could be classified as ergonomic. At all sites, the study team observed systems designed despite the need to consider person/machine interaction, with poorly placed controls and unmanageable reaches. There was a lack of input during the design process so that potentially valuable contributions from users were neglected. Furthermore, the equipment and systems often demonstrated problems with functionality and reliability which proved very frustrating to those trying to do their jobs.

In addition, there were many elements which combined to create additional stress for the individual. These included outside demands on work time (soldiering); shiftwork; lack of feedback about jobs well done; frustration with equipment failures; inadequate formal training; and heavy reliance on on-the-job training.

While many of the problems addressed above can not be solved readily, a number of general recommendations can be made for improving conditions at

the field stations. Many of these can be readily implemented, often with little additional expense.

In the short term, one of the most critical areas is that of improving the furniture systems, including chairs, at the various sites. Improving them will required detailed planning for the various activities performed by different organizational units (and likely to be performed in the near future). This analysis should consider space limitations, likely changes in technology, and the need for interactions among staff members. The criteria for furniture systems should include standardization of components, ease of adjustment, sturdiness and durability, as well as the need to facilitate frequent mission changes and reduce the "visual clutter" apparent now. Suggested recommendations include revising furniture procurement regulations to meet these criteria, evaluating long-term performance of specific systems (including chairs), and then implementing systems throughout INSCOM.

An easily implemented area for improvement is that of the color of walls, carpets, and furnishings. Use color on walls and furniture to liven up the environment and provide more visual contrasts. Coordinate color schemes for both facility and furnishings. Since painting is supposed to be performed periodically, this can be accomplished with little or no added expenditure of resources. Use paintings, artificial windows, designs, and photographs to alleviate the uniformity of the walls and provide variety and visual interest. Allow talented staff members to paint murals on large surfaces such as the tunnel at Kunia or cafeteria walls.

Another area for improvement is the functioning of the heating, ventilating, and air conditioning systems (HVAC). Recommendations include development and implementation of a regular maintenance program (that is followed faithfully) for all facilities, continued implementation of the upgrades for Berlin with installation of insulation for the analytic areas to increase temperatures, and balancing the systems so that there are not excessively cold and hot areas in the same space. At Kunia, implement the planned upgrades to the entire HVAC system. If that, combined with regular maintenance does not solve the problems of mold, dust, and other contaminants, then do a survey of the indoor air quality with particular attention to biological contaminants.

Easily implemented recommendations for improving the illumination conditions at the field stations include using uniform fixtures and lamps throughout given work areas. Do not mix light sources (such as cool white and warm white fluorescent) within a single fixture or room. Maintain a uniform stock of replacement lamps to ensure that future changes in lamps do not create the same problems that now exist. Performing regular preventive maintenance, cleaning, and relamping will increase fixture life and decrease problems of flicker. Plan the arrangement of systems and furniture so that light sources do not shine in a person's eyes or on his/her screen.

Longer-term recommendations include using localized lighting controls for

both switching and dimming for all major activity areas. While pull cords are an effective means of control, more elaborate electronic switching systems are now available that would allow both dimming and switching from central or individual locations. Provide fully adjustable task lighting for all positions requiring it. Provide the capability for adding lighting for maintenance when equipment is being designed. Use better color rendering light sources such as the "designer" fluorescent series to improve the appearance of people, walls and furnishings. Consider increasing the illuminance in public areas such as hallways, break areas, and cafeterias beyond the 10-50 lux often available now. Consider the use of wall washing or spotlighting in operational areas- to illuminate maps and posters, increase the apparent size of the space and provide visual interest. Consider the use of up-lighting in operational areas to direct light up toward off the ceiling to add illuminance to the space without increasing screen reflections and glare. Finally, consider the use of light pipes at Kunia to bring daylight into the dining room or lighted displays to simulate outdoor scenes.

Recommendations to improve the acoustic conditions at the facility include isolating major noise sources such as printers, teletypes, ventilators, from the work floor by moving them to a different room or behind acoustical partitions. Replace noisy equipment, which is usually out-of-date, with quieter, more efficient devices. Another important area is the need to initiate a hearing conservation program to determine whether current operator practices have resulted in substantial hearing losses. This program should also provide additional training to operators to use their equipment more effectively without damaging their hearing. Finally, upgrade equipment to enable operators to selectively filter noise, thereby improving the signal/noise ratio and improving job performance.

Recommendations for space improvements include the obvious need to inventory and discard unnecessary equipment on the work floors. Consider the use of space saver desks and work stations. Think vertically (as long as people can still reach items stored above) rather than horizontally and consider using integrated workstations to maximize the limited space available. Evaluate such furniture before procurement to determine its sturdiness, likely durability, and functionality in typical tasks. Finally, locate operational systems carefully with respect to lighting, HVAC, and electrical systems to reduce problems of glare, drafts and inadequate power.

Long-term recommendations include the need to develop more automated procedures (such as computer disks compatible with current systems in use at the field stations), for supplying maintenance information for systems operation and repair.

Other recommendations include the need for early input to the design process by the systems office and potential users Develop formal system to collect input from the field and obtain periodic feedback about system performance. Use operations and maintenance people from the field in making design and operational decisions at Headquarters. Ensure that

authorized representatives of field stations provide feedback to the design and maintenance process.

Use the information center to support administrative activities as well as operational and analytic efforts. Train appropriate administrative personnel in the requisite computer languages and packages. Standardize hardware and software for all users as much as possible to increase ease of support and maintenance. Increase all users awareness of the system capabilities. Network major systems and develop electronic mail capabilities for administrative tasks. Ensure that each primary staff member has a terminal.

When designing new facilities and upgrading old ones, use flexible power and telecommunication systems to ensure maximum capability of responding to changing mission and equipment needs. Provide capability of moving lighting, power, heating/cooling outlets, and telecommunication systems in each space to minimize future problems. Above all else, plan for changing personnel and equipment needs.

Implementing the recommendations listed above will help a great deal in improving environmental and working conditions in the field stations. Many of the recommendations can be easily implemented with little additional cost yet will have substantial impact by allowing the dedicated personnel who work in these facilities to do their jobs more effectively and with less frustration.

1. Background

Many military and civilian employees of the U.S. Army are required to work in environments unlike those experienced by most other workers. Their working environments are characterized by windowless spaces, highly automated equipment, and work tasks requiring utmost concentration. These conditions have led to employee complaints concerning lighting, air quality, thermal environmental conditions, lack of view to the outside, and rotating work schedules that add stress to an already complex work situation.

Because the working conditions described above are believed to detract from job performance, the U.S. Army sought assistance in identifying the problems and developing guidelines for suggesting environmental and other changes to ameliorate the problems.

Many interdependent conditions impact the work environment of the individual. These conditions are based on the work performed, and environmental conditions, as well as design, technological, ergonomic, organizational, and personal issues.

The present study examines jobs that are inherently difficult and stressful. People are under pressure to perform because of the importance of their work, and the constant need to meet hourly deadlines. Adding to their stress are continual changes to jobs and equipment, daily, weekly, or monthly changes in work schedule, requirements to master the latest technology, and the low priority given to environmental issues in the budgeting process. Environmental concerns are recognized primarily as they impact equipment rather than human performance. The result is a difficult job in a setting not conducive to optimal work performance.

Yet despite the fact that technology plays a key role in accomplishing the mission needs, one major factor appears to be overlooked. Most of the systems, both those in place and planned, are not fully automated. Instead, systems performance is heavily reliant upon those called upon to operate and maintain them. They are man-machine systems in every way. Yet the overriding impression apparent after visiting and collecting data in field stations that the people staffing such installations are subservient to the technology. Environmental and operational systems are designed to optimize technology, not to serve operators and other personnel at the field stations.

1.1 Objectives of the study

1. To determine the specific nature of the general environmental problems existing in current U.S. Army field stations.

2. To plan and conduct a research investigation to document the kind and scope of problems encountered in the field stations.

3. To propose means of overcoming the problems encountered.

1.2 Technical Approach

The study was performed in two phases. The first consisted of a literature search, interviews with experts, and planning and conducting a pilot study at two field sites. The second phase was a comprehensive field investigation at three sites, including in-depth interviews with personnel, a detailed questionnaire survey, and field measurements of lighting, air quality, noise and other environmental attributes.

1.3 Phase 1

The primary purposes of phase 1 were to gain a better understanding of existing environmental problems, develop, test, and refine data collection methods, and plan for the extensive field study in phase 2. The specific tasks completed were:

1. A literature search of relevant research.

2. Development of data collection methodologies for further field studies.

3. Conduct pilot studies at two field locations.

4. Evaluate findings of above and submit a detailed research plan for phase 2.

Following completion of the study phase, the findings were reported in NBSIR 87-3606, entitled "Interim Survey of Selected Military Building Environments: A Research Approach", by Rubin and Collins (1987).

1.4 Phase 2

The environmental assessment performed in phase 2 was an in-depth evaluation of physical conditions such as lighting, noise, temperature, humidity, and (limited) air quality, and determination of the user responses to these conditions. An analysis of the tasks performed at the site was also undertaken to determine the effect of environmental and other design factors on work performance. User response data were obtained in several ways: in-depth personal interviews with key people; detailed environmental questionnaire of a representatives sample of site personnel; and observations of working environments and jobs.

The phase 2 tasks were to:

1. Conduct a "full fledged" field study with physical and performance measures at three field sites. The specific study design was based upon the findings obtained during phase 1 and reported in Rubin and Collins (1987).

2. Examine in detail the types of tasks performed by employees to determine the likely combined effects of work, environmental and other factors on the ability to perform their assignments.

3. Recommend means of alleviating the problems identified.

1.5 Scope of the Current Report

The present report presents general findings and conclusions about the environmental conditions at three Army field stations. It also presents a series of recommendations for alleviating the problems identified at the time of the visits to each field station. A companion report, "Analysis of Environmental Data from Three U.S. Army Field Stations," by Collins and Rubin presents detailed results from the questionnaire and the physical measurements. It also contains the questionnaire and physical measurement forms. This latter report serves as backup material to the present report.

2. Experimental Procedures

Three field stations were examined in detail: Kunia, Hawaii; Berlin, Germany; and Augsburg, Germany. The activities performed and the general environmental settings at these locations are considered to be representative of similar installations throughout the world. The three stations visited were all windowless facilities, with Kunia being underground. For convenience, the major tasks performed have been categorized into three major groups; operations (the collection of information), analysis, and administration (which also includes clerical, maintenance, and other.

2.1 Questionnaire Survey

Detailed environmental questionnaires were distributed to a sample of the people at all sites. The individuals sampled were selected on the basis of the activities performed and their location. (A copy of the questionnaire and a detailed discussion of the findings is given in the companion report. Selected graphs of results from the questionnaire are given in the present report as support for specific findings and recommendations.)

A breakdown of the questionnaire sample by location is as follows:

	Operators	Analysts	Admini-strators	Total
Kunia	154	77	42	273
Augsburg	124	52	41	217
Berlin	69	32	30	131
Total	347	161	113	621

2.2 Physical Measurements

Concurrent with the questionnaire survey, measurements of several physical environmental characteristics were made. These included lighting measures (luminance and illuminance), noise, temperature, humidity, air flow and physical dimensions of workstations. Other assessments included color, sound intrusiveness, chair and panel design and quality, furnishings and wall type, carpets and personalization of space. (The form used in collecting these data is included in Appendix B, with a detailed discussion of the findings in the companion report.)

Physical measurements were taken at a total of 279 workstations. The breakdown of measures were as follows: 62 at Berlin, 79 at Augsburg and 138 at Kunia. The primary focus of these measures was on the lighting conditions at the workstation with a major variable being the presence or absence of VDT's. Of the 279 workstations, there were 171 workstations with VDT's, and 108 without them.

Not all measures were taken at every location because of the similarity of findings within a room. Most of the operators and analysts were located in large open-plan areas so that noise levels at one workstation were the same as those at the next. Generally, the levels throughout the facility were quite uniform. For the most part, they did not vary more than four or five dBA from place to place, except in the presence of major noise sources such as high speed printers. Consequently, sampling a limited number of locations was sufficient to indicate its likely environmental impact, with questionnaire data supplying subjective information. In addition, the overall ambient levels on the working floor (typically about 60-65 dBA) were well below those that could cause any hearing damage to personnel. Even in the vicinity of major noise sources such as printers or generators, the levels usually did not present any major health problem. However, in several instances, noises were sufficiently loud and intrusive (between 80-85 dBA when a printer was operational) to create a major annoyance.

Temperature and humidity levels likewise were relatively uniform within major areas of the facilities, although they did vary from area to area and from time to time. Consequently, a limited number of readings were sufficient to indicate the general working conditions. (Detailed findings of all environmental conditions appear in the companion report).

The one environmental topic dealt with in considerable detail was lighting. It had been identified as a major problem area which "triggered" the initial investigation of the field stations. Furthermore, the variability of lighting at all sites elicited many unfavorable comments by people performing a variety of tasks in different locations. The analysis revealed considerable variation in overall light levels, light source position, and task contrast (particularly for VDT's).

2.2.1. Temperature and Humidity Measurements

Measurements of temperature, humidity, and air speed were made using a Solomat[1] multi-channel modumeter (2016). The device automatically cycles from temperature to airspeed to humidity and back to temperature. A platinum thermohygrometer was used to measure temperature and humidity while a hot wire anemometer was used to measure air speed.

Using a stand constructed for the probes of the Solomat, measures were taken at individual workstations by placing the system at typical working positions. The readings recorded were those of the third cycle, to permit the measurements to stabilize. The equipment was calibrated prior to the field visits. (Air speed readings were very variable, depending on location and therefore are not covered in any detail in the report.)

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[1] Brand names are provided for identification purposes only and do not constitute endorsement by the National Bureau of Standards or the U.S. Army.

2.2.2 Acoustic Measurements

Acoustic measurements were made with a Quest[1] model 155 precision hand-held sound level meter and a standard 1/2 inch condenser microphone with an OB-145 octave band filter attached. The equipment was calibrated before use at each field station. Ambient sound levels were made on the dBA scale, slow reading (1000 msec time constant). Octave band analyses were made after the ambient measures. Fast responses (125 msec time constant) were taken when the noise sources were variable, primarily when measuring headset output.

Acoustic measurements were made at workstations and in the vicinity of major noise sources, such as high speed printers, teletypewriters (TTY), fans, and blowers.

2.2.3 Illumination Measurements

A hand-held Minolta[1] photometer with a cosine-corrected diffuser and a photopic response filter was used to measure illuminance (the amount of light falling on the work surface). Illuminance was measured at the primary task location - the position where the person normally worked with the chair occupied. Measurements were made at the center of the working area, where a standard target was positioned. When a VDT station was present, illuminance was also measured at the screen and keyboard, with the room lights and monitor in their customary setting. In several cases, additional measures were taken with the room lights altered from their normal setting (either to on or off.)

A portable Minolta[1] luminance meter with a one degree viewing angle was used to measure luminance (the light reflected from a surface). Measures were taken for a standard target containing white, gray, and black surfaces, the ceiling between luminaires, and for the brightest and darkest surfaces in the field of view. Where a VDT was present, luminance measures were taken at the center, left, right, top, and bottom of the screen as well as of two individual characters. While the viewing angle of the luminance meter covered the entire character, it also covered a small amount of surrounding screen area, so that the measurement includes character and background. Nonetheless, this procedure appears appropriate for making relative brightness comparisons of screen characters for different types of equipment and light sources.

Other lighting related data were the type of overhead luminaire and its position relative to the workstation as well as any switching controls available. The presence, type, illuminance, and luminance of any task lighting were also recorded. Finally, observations were made concerning the presence or absence of visible reflections on the VDT screen.

2.3 Observations

A similar procedure for obtaining information was followed at each field station. The visit began with a general briefing on the major activities performed at the field station, followed by a walk-through of the entire

facility. During this phase, there was an opportunity to observe the overall environment, the organization of working groups, and conditions at individual workstations. Operators, analysts, administrative staff, and maintenance personnel also provided a detailed briefing of the various activities they typically performed during a day and noted significant problems that they encountered. This activity identified the tasks to be analyzed in depth, as well as the key individuals to be interviewed.

These initial observations enabled us to examine such factors as the overall lighting scheme, general environmental conditions such as temperature, the organization of spaces, workstation layout, and the general appearance of floor areas, furnishings, ceilings, and walls. It also served as an "early warning system" of problems requiring examination during later study phases.

2.4 Interviews

Personal interviews were conducted to provide "in depth" information concerning specific major issues and provide the chance for people to make general comments about their work situation in an unstructured way. The topics discussed ranged from the organization of a particular task, environmental issues, planning and implementation of new technologies, to stressors in the workplace. Sometimes, interviews were conducted "one on one" while in other instances, a group of people were brought together to discuss common concerns.

The information collected during the interviews provided tangible examples of many of the general concerns expressed in the questionnaire surveys. They present a subjective dimension to the more objective data which are summarized in tabular and graphic form in the companion report. More importantly, they provide insights concerning the depth of feeling concerning given issues. The interviews are given in Appendix C of the present report.

In gaining an understanding of ergonomic (man-machine) problems, the best data collection method was often a combination of observation, demonstration, and interview. For example, some task sequences could only be understood by having operators perform them while explaining what they were doing, and responding to questions simultaneously. In this way, the physical, mental, and environmental constraints and demands came into focus.

The findings will be discussed from two viewpoints; issues that seemed to be common ones, and those that were largely confined to a single location. For the most part the results indicate that the major problems encountered are generic and occur at all field stations rather than being site specific. Differences are usually in the form of how the problems are manifested due to particular site, organizational, and technological factors.

3. The Buildings

In the following sections, the italicized comments at the end which were given by field station personnel during the interviews and in the questionnaires are used to provide a sense of the kind and magnitude of the environmental and task-related problems encountered at the different sites. In some cases people also provided possible solutions for problems that frequently bothered them. The comments are given in italics, with the name of the field station at which they were taken preceding them.

Figures and tables are drawn from the questionnaires and the physical measurements and again provide an indication of areas where personnel perceived problems.

3.1 Building Systems

3.1.1 Heating, Ventilation, and Air Conditioning (HVAC)

The field stations are organized, conditioned, and maintained primarily to ensure that equipment needs are met; people must accommodate to these conditions as best they can. The lack of standardization gives many spaces a makeshift appearance. For example, fixtures and lamp types often differ in a single space as well as between areas.

At some sites, because the heating, air conditioning, ventilation, and electrical power systems were modified from their original design uses, environmental problems are common. At one site, the HVAC system was not designed to handle the large number of people and sophisticated electronic systems that have been added. It does not "condition" the air; it merely circulates "fresh air" throughout the site. As a result, unacceptable levels of humidity build up causing mold and mildew problems. In other cases, the HVAC equipment is not sized properly for the thermal loads. The result is that work stoppages frequently occur when the temperature exceeds a level required for the equipment to operate, or personnel freeze because the cooling demands are exceeded. In some areas, large fans must operate continually to accommodate air circulation requirements. These fans contribute considerably to the overall noise levels when they operate.

Uniform temperature and air movement conditions in all buildings are difficult to achieve. As a result, temperatures in many spaces vary from being too hot to too cold, while stagnant air was mentioned by a number of the people interviewed. These latter problems were more severe in the office areas, where some administrative functions are separated by space dividers and housed in private offices. The appropriate balancing of heating and air flow systems was said to be an ever-present issue.

Although the buildings are not insulated; and there do not appear to be any plans for installing insulation. (Some has recently been installed

at Berlin, however, which may mitigate some of the temperature problems there.) The use of supplementary heaters is permitted in Berlin and Augsburg, but its application is piecemeal.

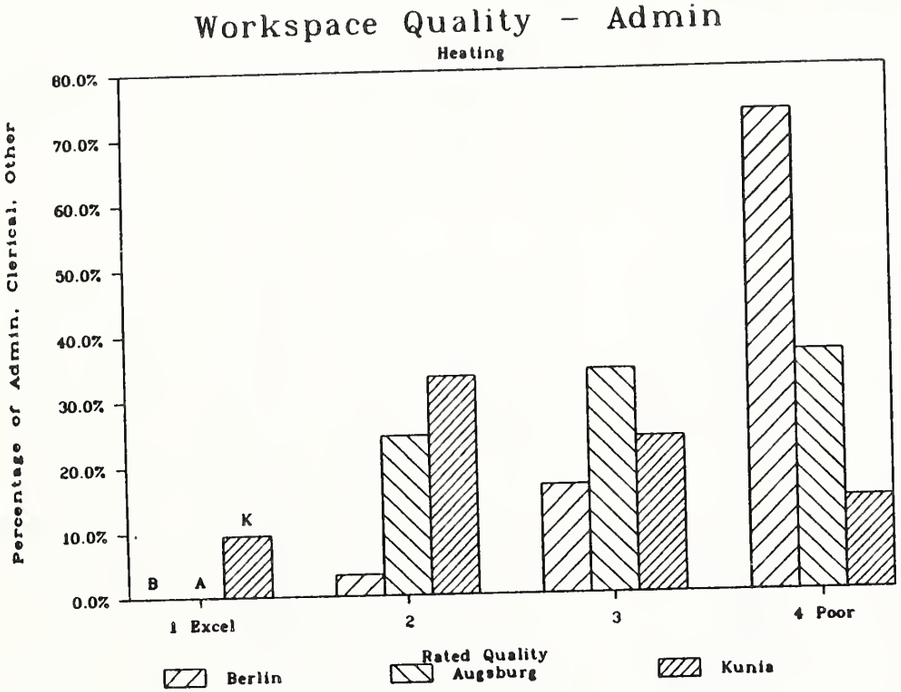
Figure 1 provides data on the reaction to temperatures at the three field stations. In this figure, as in all subsequent figures, three separate graphs are given. The upper left graph presents data for the administrative and clerical personnel at all three sites, the upper right graph presents data for analytical personnel, and the bottom graph presents data for operational personnel. Within each figure, the response for Berlin are given first, followed by those for Augsburg, and then those for Kunia. The abscissa gives the rating scale, while the ordinate gives the percentage of people responding within each classification. Figure 1 demonstrates that people believed that temperatures at Berlin and Augsburg were often uncomfortably cold, particularly in the operational areas were more than 65% of those questioned indicated that the heating was quite poor.

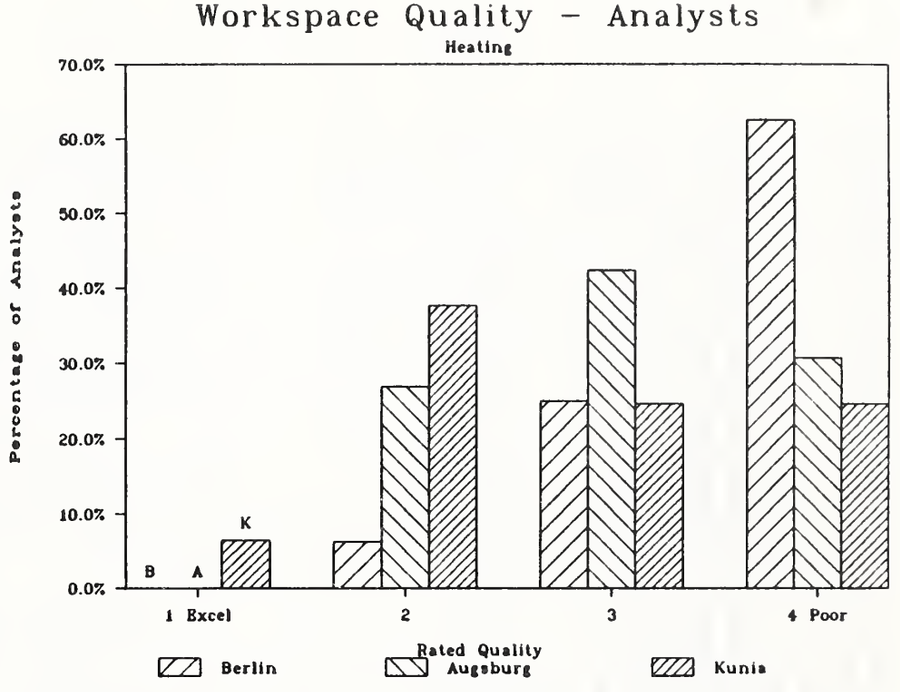
Comments from the Occupants

Berlin:
Occupant comfort is a big problem on the third floor. There is a dire need to isolate the operator from freezing temperatures. One system with a directed air flow had overheating problems. They ended up putting holes in the equipment to keep it from failing. Operators end up wearing field jackets, gloves, and sweaters, because it is so cold. Many stresses exist due to both equipment and environmental problems.

Augsburg:
The temperature ranges from uncomfortably cool to down right frigid. It is usually so cold year round that field jacket or gloves are comfortable attire; these inhibit work. We must wear winter clothes all year. It's too cold in our work area.

Kunia:
One problem is that the air handlers move air, while cooling; it gets very cold in midshifts. When it's cold upstairs, it's very cold down here. As you can see, I'm wearing a sweater.





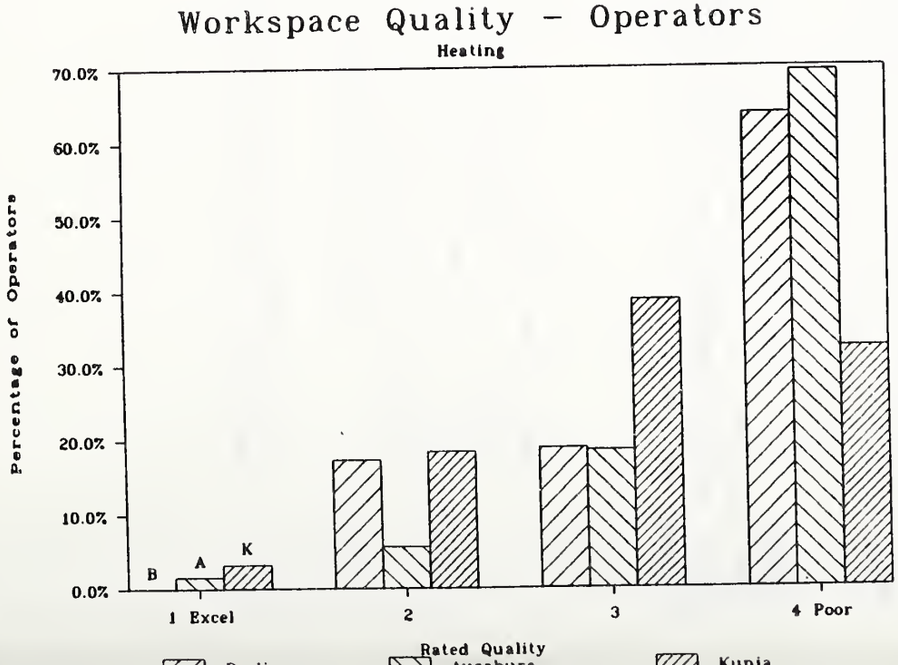


Figure 1 Reaction to the Quality of Heating for Each Location at Each Site

3.1.2 Lighting

A major source of complaints, reinforced by the collection of physical data and observations, concerned lighting. Several types of problems are apparent, ranging from appearance to functionality.

The lighting systems in many areas are characterized by lack of uniformity and failure to perform regular maintenance. When walking through any field station one can observe a variety of fixtures, lamp colors, diffusers, etc. Warm white, cool white and even daylight fluorescent lamps are frequently mixed within the same fixture and/or room. Many luminaires are dirty and have one or more flickering lamps. The overall appearance contributes to environments that are unsightly and depressing (to staff members as well as visitors). Overall illuminance levels are very low - typically well below the 50 fc (500 lux) recommended by the IES for office spaces but within the guidelines for spaces with VDT's (IESNA, 1987).

Illuminances

	With VDT	Without VDT	Mean
Berlin	234 lux	370 lux	282
Augsburg	140 lux	235 lux	161
Kunia	158 lux	382 lux	368

The inadequacy of maintenance seriously diminishes light output and results in many situations where the available light is inadequate for the work being performed. The flickering is also a major cause of complaint by those nearby, and may contribute to malfunctioning of equipment due to electronic noise.

Controlling light output is frequently an ad hoc operation, ranging from placing paper or cardboard over lamps to serve as makeshift diffusers, to the removal of lamps by working personnel. These options are used primarily by those in operations who spend 8 hours a day at their VDT screens. Analysis of task contrast indicated that contrast on the VDT screens was higher in the operational levels where the overhead lighting had been dimmed. This reconfirmed measurements taken during the pilot study at Kunia where operators had insisted that they see "better" with the lights dimmed. There, measurements with the lights on revealed a marked decrease in screen contrasts, relative to the situation with the lights off. (At the same time, however, reading paper copy becomes more difficult as does writing. At one site, for example, operators were required to write on brown envelopes with pencil - a very low contrast task made even more difficult by the low lighting.)

VDT Screen Contrasts

	Berlin	Augsburg	Kunia
Operations			
Keyboard illum	167	71	71
Screen Contrast	0.90	0.83	0.90
Analysis			
Keyboard illum	104	124	243
Screen Contrast	0.91	0.72	0.80
Admin			
Keyboard illum	671	128	394
Screen Contrast	0.62	0.74	0.80

Localized lighting control is not available for most people, with the exception of the few with task lighting. A dimming option is never available, while switching usually consists of turning on/off all the luminaires in a room. One of the most significant answers on the questionnaire was in response to a question about the ability to adjust the light on the task. As Figure 2 demonstrates, more than 70% of those questioned at all sites felt that their ability to adjust light was very poor.

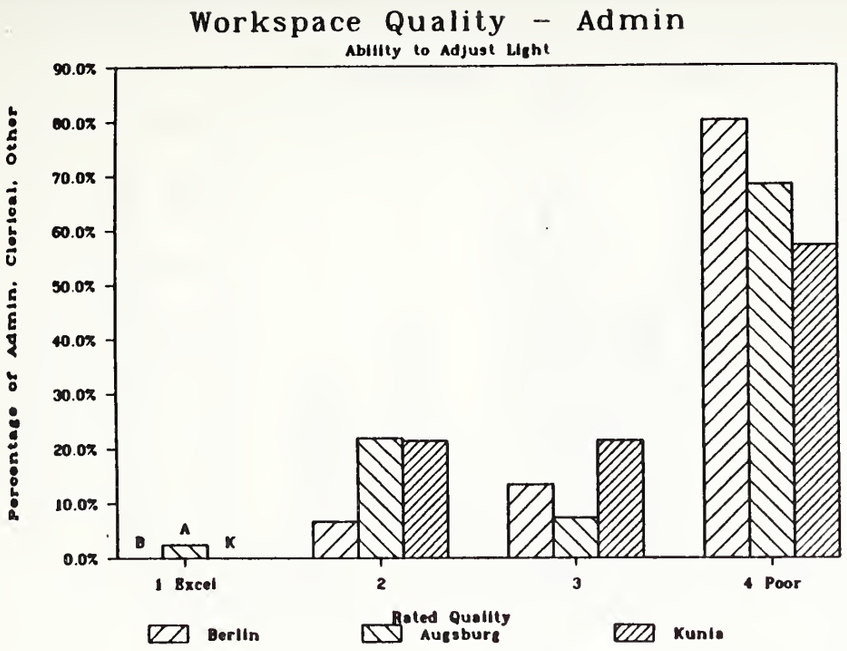
Comments from the Occupants

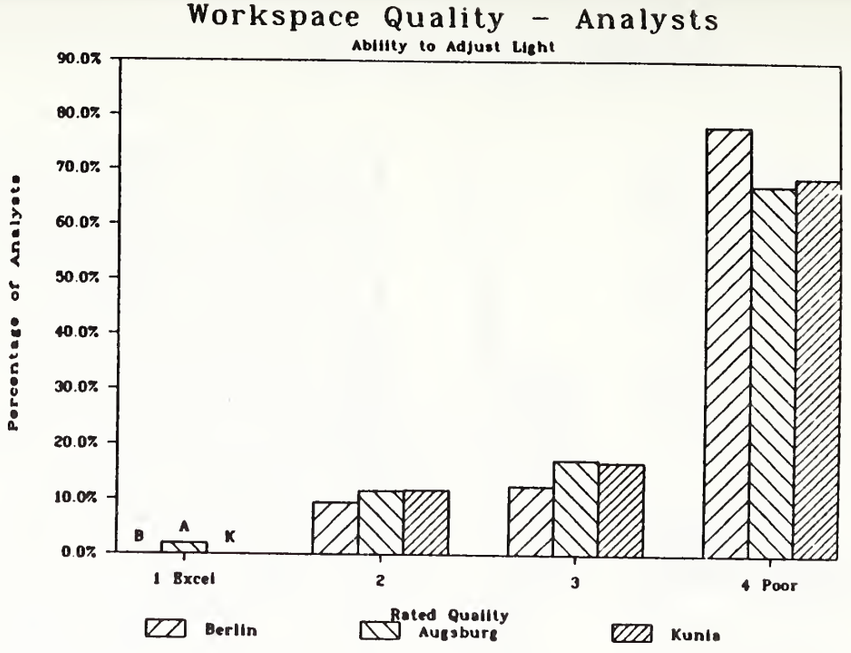
Augsburg:
Need to be able to see what we're doing without straining eyes. Lighting is the pits. It's like working in a cave. Lighting is bright in some areas; dim in others/strains eyes. Too much glare on screens and scopes gives me headaches and hurts my eyes.

Lighting is too low for reading. I should be able to adjust my own lighting area. Overhead fluorescent lights cause glare, they are always flickering and give headaches.

Berlin:
Desk lamp would be a nice touch. Decide either blue, green, dark, or bright.

Kunia:
Being under fluorescent lights all day with brick walls is annoying. Even after three years, without expecting it to be annoying. People complain about the lights; many of them are out. There are frequent complaints of headaches. When the light here is turned on, the glare comes directly on the screen. The alternative is that a light comes directly on your eyes.





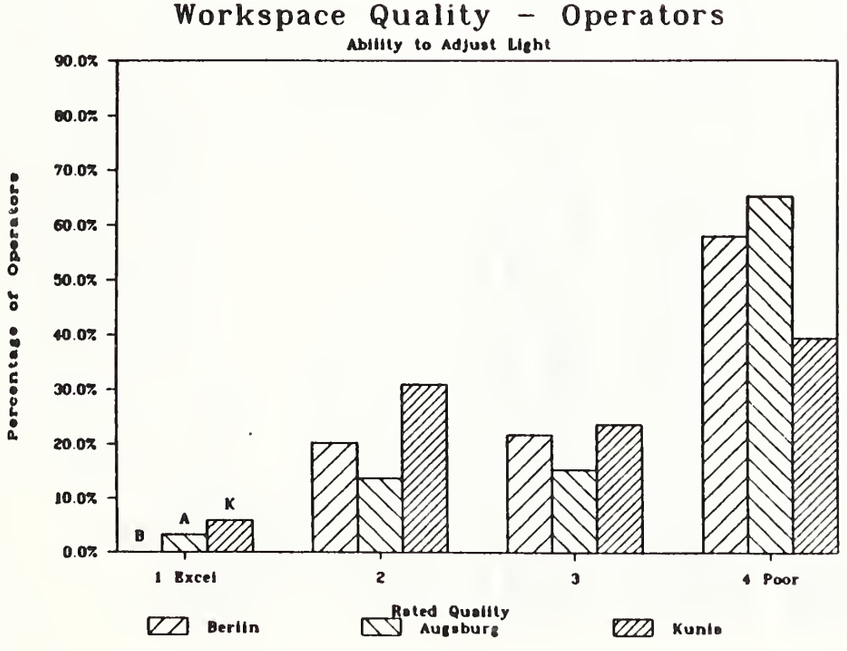


Figure 2 Reaction to the Ability to Adjust Light for the Workstation

3.1.3 Acoustics

Many of the key activities performed at the workstations are extremely noise sensitive. They are based upon aural communications of various types, with the information to be understood often embedded in electronic noise. The presence of major environmental noise sources makes the required task much more difficult because the signal-to-noise ratio is significantly degraded. Under these circumstances, there are three likely outcomes:

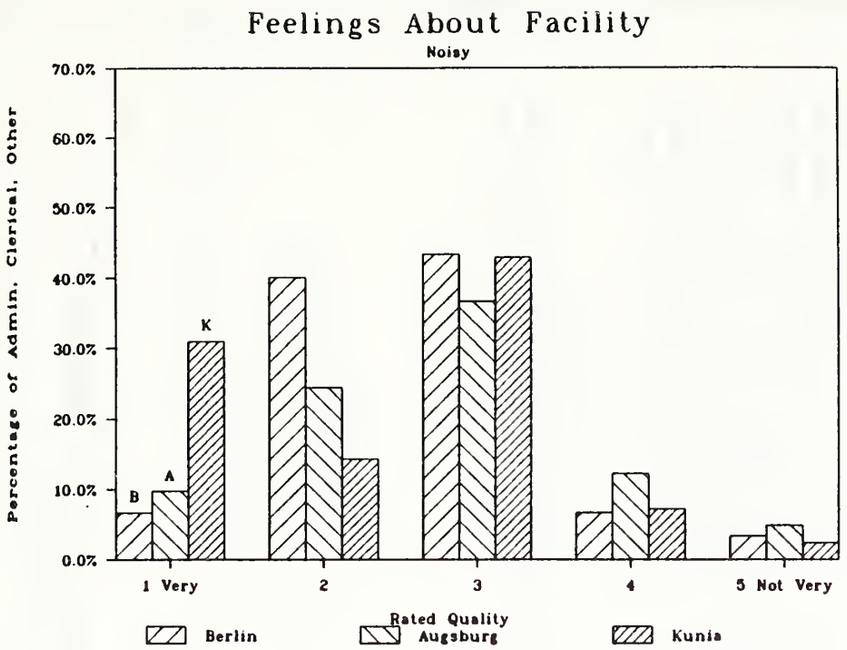
1. It takes longer to perform the tasks.
2. There are likely to be more operator errors.
3. Performing work under these conditions is very difficult and demanding for the worker.

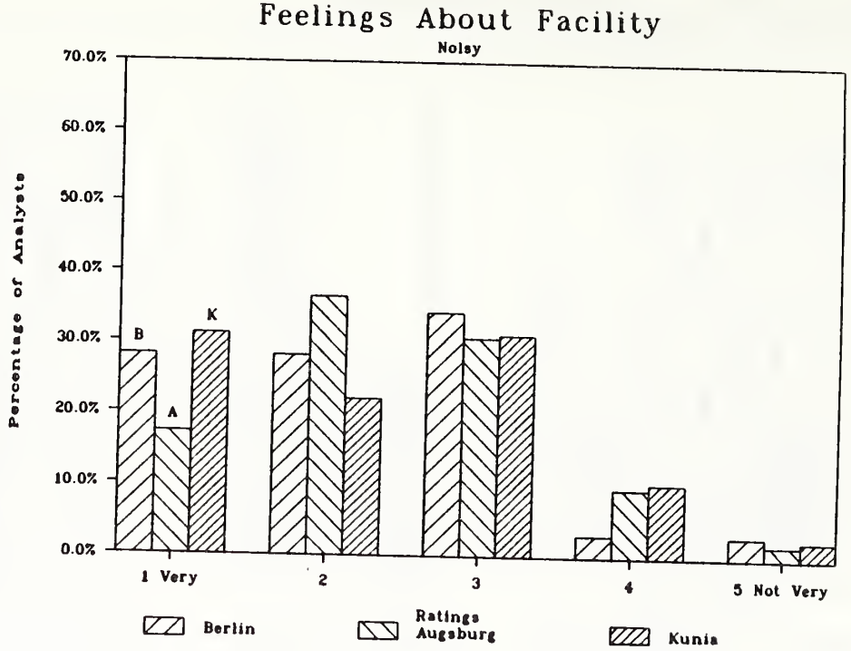
The noise problem is intensified by the 'hard' surfaces of the walls and the general lack of soft surfaces anywhere that might absorb some of the sound. The equipment, walls, and floors all serve to reflect sound, resulting in a workspace that in many ways serves as a reverberation room. As a result, overall sound levels approach those produced by the major noise sources within the space. Instead of minimizing the detrimental effects of noise, the local environment maximizes it. In addition, in the operational areas additional air handlers have often been added to cool the equipment. These often generate a noticeable hum which adds to the overall distraction. At one site, the noise from this equipment was sufficiently annoying in one area that it was not used for office space, but rather reserved as a break area. (How relaxing this was for personnel is unclear.)

The analytical and administrative areas are typically open plan offices with many people sharing a common space. In these areas, conversations and ringing telephones are major irritants, as well as the occasional loud printer. (Some printers were measured at 80-85 dBA while operational.)

Figure 3 presents data on the feelings about noise and annoying sounds within the field stations. The problems are greatest for the analysts as seen by the number that rate it as very (1) or somewhat (2) noisy.

Another problem is that the noise producing equipment does not have any acoustical treatment such as equipment covers which could significantly reduce the sound locally, as well as have some effect on noise levels in the general environment.





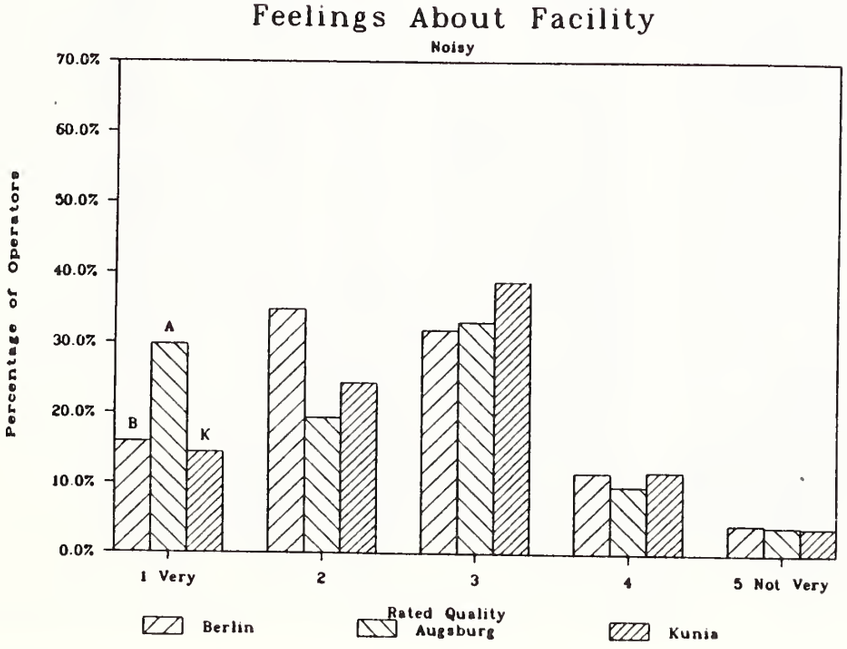


Figure 3 Reaction to Noise and Annoying Sounds

Environmental noise at the field stations is created by operational equipment, building equipment, and by people. For the most part, it is a disruptive influence (making work difficult) as opposed to being a health hazard. Antiquated equipment, particularly TTY's and printers, are the most prominent sources of complaint, primarily due to their proximity to many workstations which do not use them during the course of the day. Partitions are of limited help in isolating the noise sources, because the noise penetrates them.

Comments from the Occupants

Augsburg:
Too much noise; it's quite distracting to me. Noise level of everything put together (vents/people, printers) is too high.

Kunia:
Too many beeps, buzzers, phones and printers. Noise levels are very high because of the amount of equipment and people crammed into a small space.

3.1.4 Air Quality

Air quality was a problem in a number of areas within the field stations, but particularly at Kunia. Many complaints focused on the lack of ventilation and stuffiness. Most of the problems there are attributed to lack of maintenance. With respect to cleaning procedures, the air conditioning system is supposed to have monthly, quarterly, and yearly inspection; monthly, they should clean the filter, oil the system, and generally check the operation; quarterly, they should clean the unit and check the bearings; annually, they should do a total cleanup of ducts, AC unit, everything. In fact, the Kunia field station is years behind on all maintenance. The result is that mold, mildew, and dust are common occurrences on walls and surfaces, particularly in non-operational areas (which do not have the supplemental air conditioners for the equipment). At the same time, some analytical areas were very confined and stuffy due to poor air circulation and large numbers of people in a relatively small space.

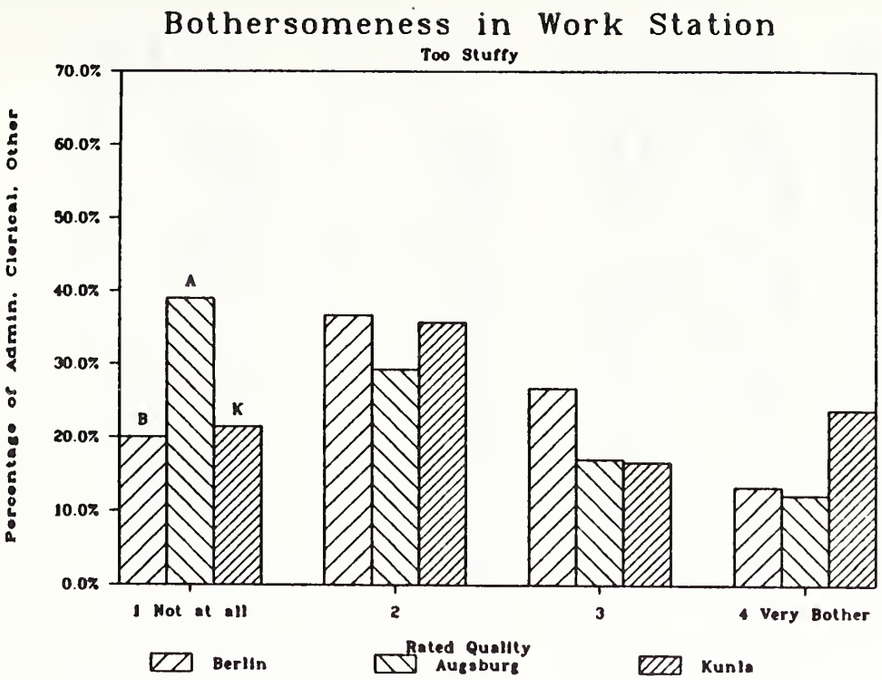
Figure 4 presents information on the bothersomeness of stuffiness at the three sites. Analysts, particularly those at Kunia, rated stuffiness as very bothersome.

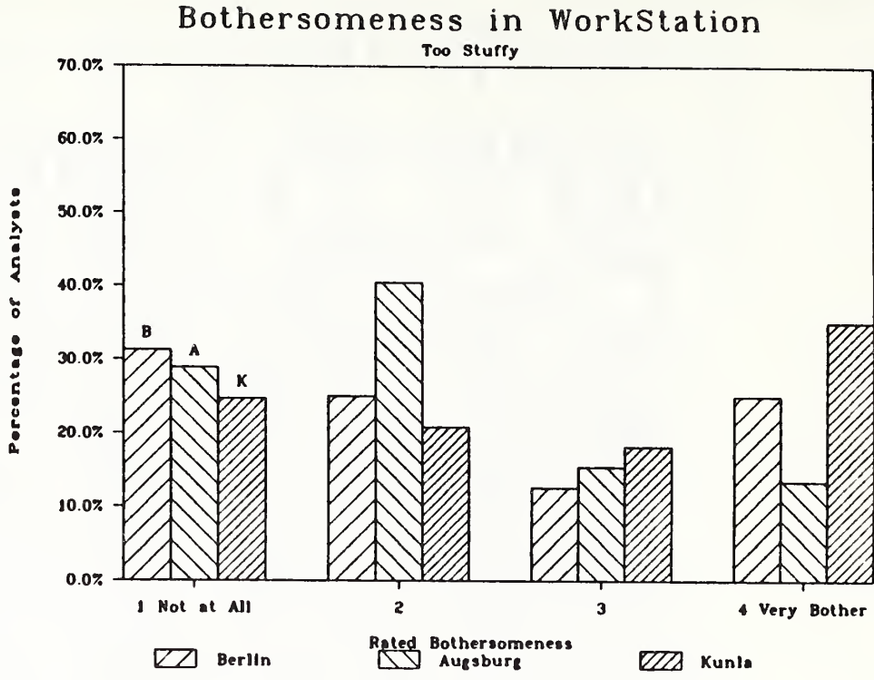
Comments from the Occupants

Augsburg:
Clean healthy air never hurt anyone.

Berlin:
Any air circulation would be an improvement.

Kunia:
The air is stale/tunnel smells bad. Air smells stale, mildewed air is stale and stuffy; fresh air is non-existent.





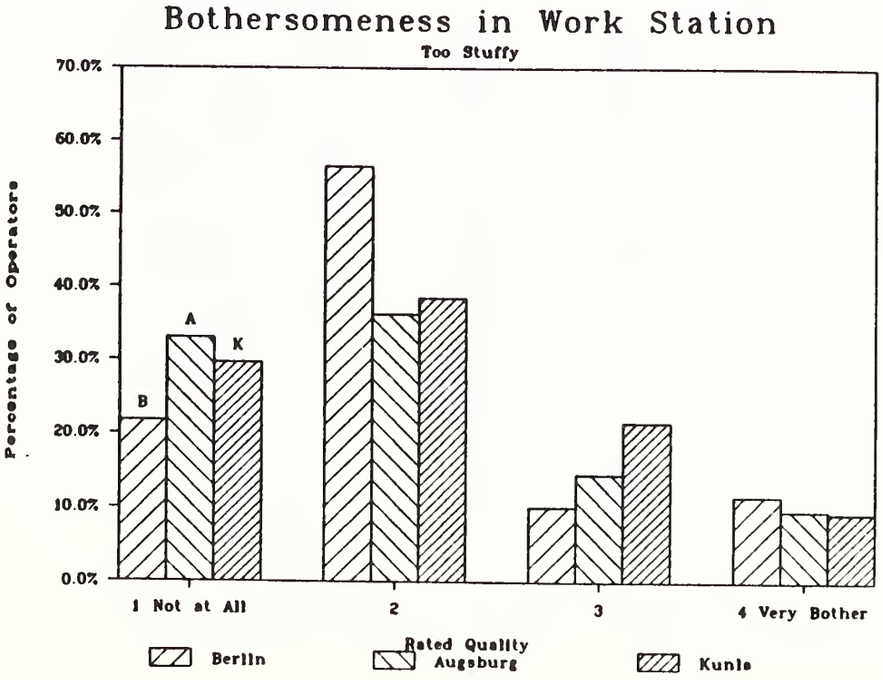


Figure 4 Information on the Reaction to Stuffiness at the Three Sites

3.2 Break Areas

The break areas at the stations are important places for personnel because they are the places available to escape from the stresses associated with the job. Possibly for this reason, these areas were the subject of many comments and suggestions for improvements. The number and kind of break area varied from field station to field station. Two of the official break areas at Berlin and Augsburg have windows, vending machines, chairs, and tables, so that some escape from the job routine is possible. Yet, these areas are about a 2-5 minute walk from the operational areas, making them less accessible than might be desired. In Berlin, a break area is located off the operational floor near the latrines - which have a tendency to smell bad, particularly after the weekend. This area also had chairs rejected from the operational floor, very low light levels, and overall lack of attention to comfort.

Still another problem with the break areas is the need to provide separate smoking areas. At all field stations, this has been done for smokers, although they may leave something to be desired in ambience. For example, at Kunia the smoking areas are in converted latrines- several of which still have the plumbing visible. No separate air handling is provided for these small areas so that the smoke buildup is tremendous. Nevertheless, non-smokers resent the fact that no separate break area is provided for them.

Comments from the Occupants

Augsburg:
When work becomes overbearing, I need an area for breaks to help relax. The only break area is a snack bar with no smoking allowed. It is too small and often is standing room only.

We need a break area closer to work, with couch and more comfortable furniture. A room with nautilus equipment and some recreational items such as TV, game machines, pool and ping pong tables.

Berlin:
Furniture in the break area is extremely old and not comfortable. Break area looks like a disaster area.

Kunia:
Break area to relieve stress, with a couch and reading room.
Need more break areas for non-smokers as well.
It should have soda and snack machines and something on the wall other than concrete and tiles to carry on a conversation because you can't talk in the current smoking areas. It needs something more pleasing to the eye such as murals, paintings or graphics on the bulkheads,
subdued lighting, one or two plants, and magazines definitely.

3.3 Maintenance

With limited exception, the field station walls and corridors appeared to these observers to be drab and painted uniformly in standard issue pastel or dark colors. Adding to the general drabness of the appearance is that cleaning and maintenance of the walls and other surfaces was often neglected. These were often unkempt and dirty. Interview and survey data revealed many unfavorable comments about the overall quality of the environment, particularly as related to maintenance.

The area supervisor needs to care about the work environment. Many people appear to be oblivious to the environmental problems within their workspace. Changes occur only as a result of complaints, even though the facility engineers are supposed to maintain the space on a routine basis. People often make changes on their own, including painting walls, re-arranging furniture, adding non-regulation carpet, removing/adding light sources, stringing cable for equipment, etc. While their intentions are good, their execution sometimes is faulty, occasionally resulting in tripping, electrical, and other safety hazards.

The lack of preventive and regular maintenance at the field stations, particularly Kunia and Augsburg, was a major source of concern. At Kunia, for example, the lack of appropriate air conditioning maintenance was said to be the cause of many of their air quality problems, with mold and mildew being present in many locations. The rule of thumb appears to be to repair systems only when broken and not to do preventative maintenance to avoid costly and time-consuming repairs.

For example, the replacement of lamps for the lighting fixtures is supposed to occur on a regularly scheduled basis, but this does not happen in this manner. When lamps are burned out, their replacement is supposed to be routine, following the notification of appropriate personnel. Yet, considerable time usually elapses between the notification of maintenance personnel and replacement of the lamp. This can result in shortened ballast life.

Yet another problem is that because of security considerations, troops on the operational and analytical areas are expected to do the routine vacuuming and cleaning. If a crisis intervenes, this routine cleaning is not done because more important things must be done. At the same time, overall light levels are low so that dirt spots are often not seen-until time comes for a tour and the lights are turned up.

Even painting the facility is subject to some of these problems. Clearing areas so that uncleared personnel can come in and paint is very difficult and impacts the mission adversely. The regular personnel, however, do not have time to paint. In addition, the ventilation is poor enough, particularly at Kunia, that adding paint fumes into a space where people are working is not a good idea.

Where painting has been done, it usually has been in accordance with regulation; i.e. nondescript pastel colors. The lack of windows also contributes to the impression of sterility in the general environment. This is typically uniform for the general work areas, with one memorable exception. In one of the buildings, murals had been painted on two of the walls in general view of the operators. In instances such as this, where people are permitted to liven up their spaces by adding some highly saturated colors, the response is very favorable.

Figure 5 presents data on feelings about the colorfulness of the general appearance of the field stations. Almost none of those questioned felt that their facilities were colorful. Again, the analysts were the most negative about the colorfulness of their areas.

Comments *from the Occupants*

<u>Augsburg</u>:
All environmental changes for walls, lights, electrical outlets are made by the staff. Doing it by the book, filling out forms is a waste of time and months pass without anything being done. There are only three people on the maintenance staff so it is humanly impossible to fix what goes wrong. If you're going to have any change, you have to do it yourself. You bring in the stuff from home, pay for it yourself. I have to borrow drills, screwdrivers, etc to fix up the area.

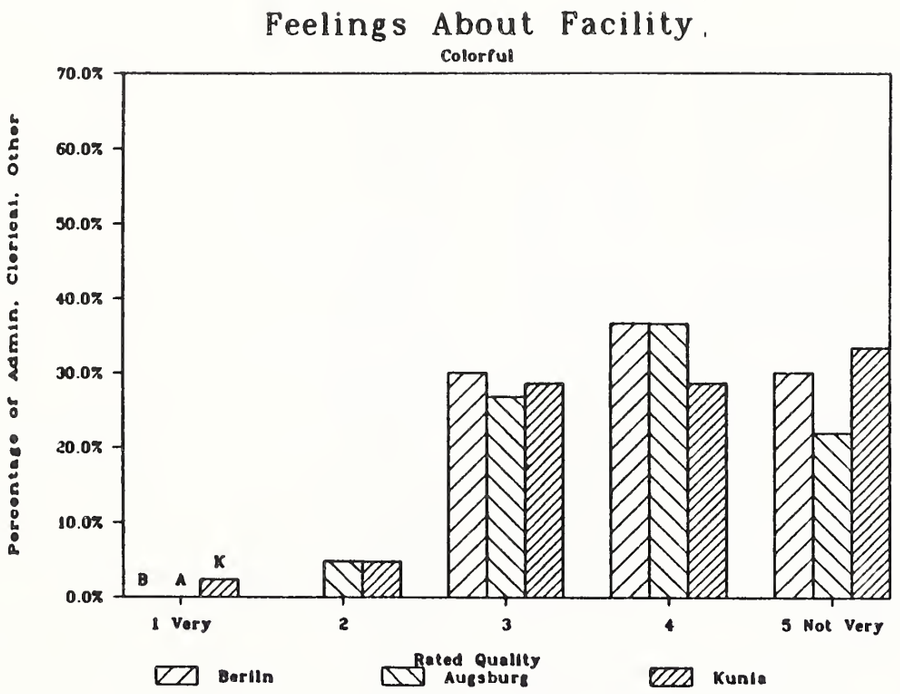
It is discouraging to be in place that's dirty even after it's cleaned. Building needs new carpeting, paint job looks like original stuff. The carpet in the passageways looks bad along with the walls.

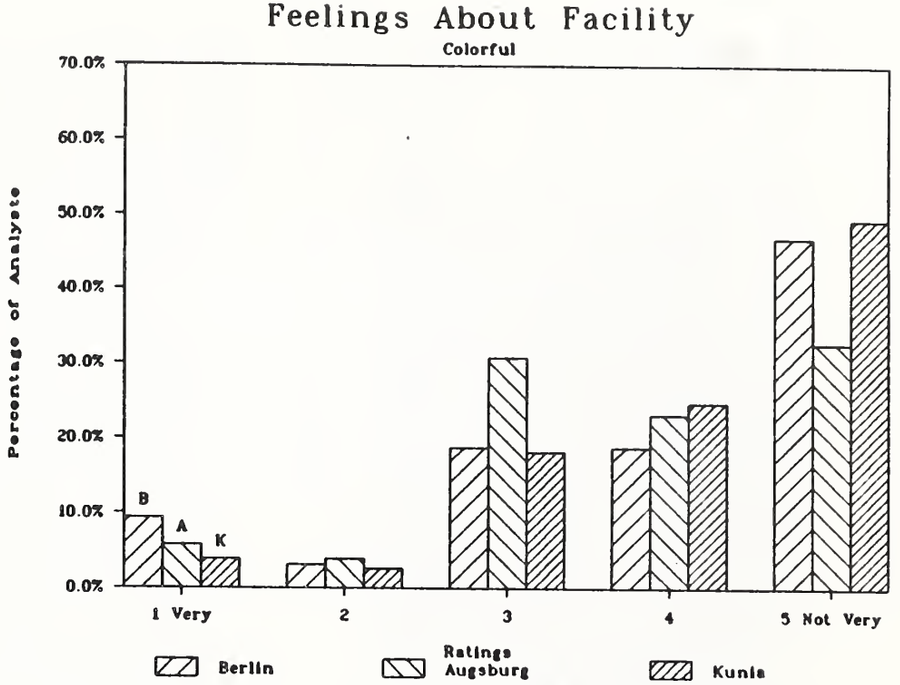
The latch breaks when you try to change the bulbs. You can't get bulbs in and out easily to change them. In the section that's supposed to do it, a work order takes months. He has been there 3-1/2 years and has never seen them come in to do anything, even check them. They're flickering like crazy. He could get stuff if he had the right connections and work order.

Colors in this office are atrocious; we need a more subtle, color coordinated scheme. Everything is either drab gray or obscenely bright orange. I like dirty white as much as the next guy but... They just painted the walls, but battleship gray isn't the best color.

<u>Berlin</u>:
This place is filthy. Cleaning of non operational areas is poor. Add cheerful colors, carpet/less stark impersonal, furniture and lockers are morbid. Varying shades of brown are depressing.

Kunia:
Walls are drab, stained, ugly and depressing. It is just terrible to ask people to work under conditions like this. The general appearance is so awful, but there is nothing that we can do about it. The whole area is dirty. No amount of cleaning will change that. It's just depressing to walk in here and look at the place and know you have to stay there for 8 hours. Whatever is done to the interior space, you're still faced with the drab and dreary tunnel. The tunnel should have murals or photographs; perhaps historical information. There are military artists in each of the services. They could each do something about their services, ships, tanks, whatever they wanted, semper fi. Perhaps they could have a contest to fix up the tunnel. It is very depressing in the tunnel; a long walk, and an ugly one.





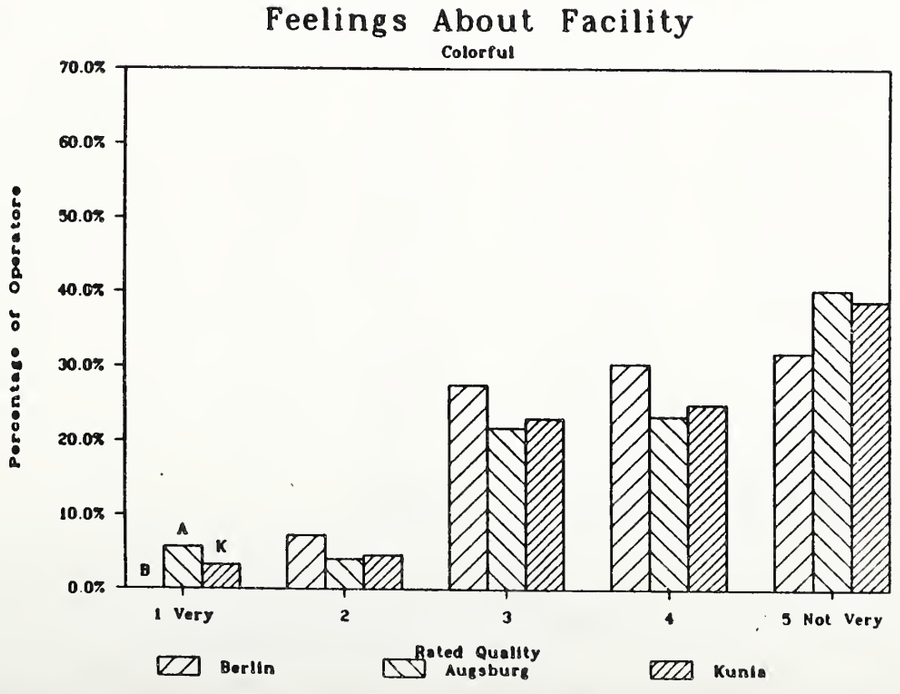


Figure 5 Reaction to the Overall Colorfulness at the Field Stations

4. Organization of Space

With frequent expansion of missions and the introduction of new technologies as they become available, space requirements undergo frequent changes. Yet formal space planning appears to occur only during facility expansion (a rare occurrence) or when new operational systems are put into place. As a result, many work areas are crowded with equipment and people. The cramped conditions are especially apparent in the analytic areas, perhaps because these areas are not subject to electronic upgrades in operational equipment and are not as visible as the administrative areas. None of the analytic areas at any of the sites had gone to raised flooring, systems furniture, or equipment upgrades that might have forced better organization of space and personnel.

4.1 Operations

At all three field stations, the operational areas were characterized by very large floor areas full of different types of electronic equipment. Each person typically uses at least one VDT monitor, if not more. The Berlin operational area had recently been upgraded with some new equipment, which had also resulted in extensive environmental changes to this floor. For example, new lighting had recently been installed with a lower acoustic ceiling, insulation had been added to the ceiling and walls, and the whole area had been painted and reconfigured. Much of the equipment came in vivid colors which also added interest to the floor. The other two sites had not undergone similar upgrades and appeared much more crowded and dingy.

4.2 Analysis

At all three sites, the analytical areas were the most crowded with very little space to spare. They were characterized by paper clutter, lack of storage space, dingy, rumpled, or torn carpets, relatively low light levels, annoying noises, stuffy air quality, and cold temperatures in Berlin but high temperatures at Kunia. These areas perhaps are most similar to conventional open plan offices, in which many people are located in one space. The nature of the job requires concentration; yet, the work area often makes this very difficult.

4.3 Administrative/Clerical

The quality of the administrative space varied dramatically from site to site. The spaces were very crowded at Augsburg with conditions made even less pleasant by the combination of very low light levels and dark blue or green wall colors (often in the same space). While spaces were crowded at Berlin, not all spaces were as badly crowded as those at Augsburg. In addition, wall colors were typically white or cream and illuminances were higher so that the spaces did not appear as dingy and cramped. Kunia had some of the least crowded spaces with the highest light levels.

Figure 6 presents data on the overall satisfaction with space for different groups at the three field stations. This figure suggests that the administrators, particularly those at Kunia are the most satisfied with their space, while the analysts, particularly those at Berlin are the least satisfied.

Comments *from the Occupants*

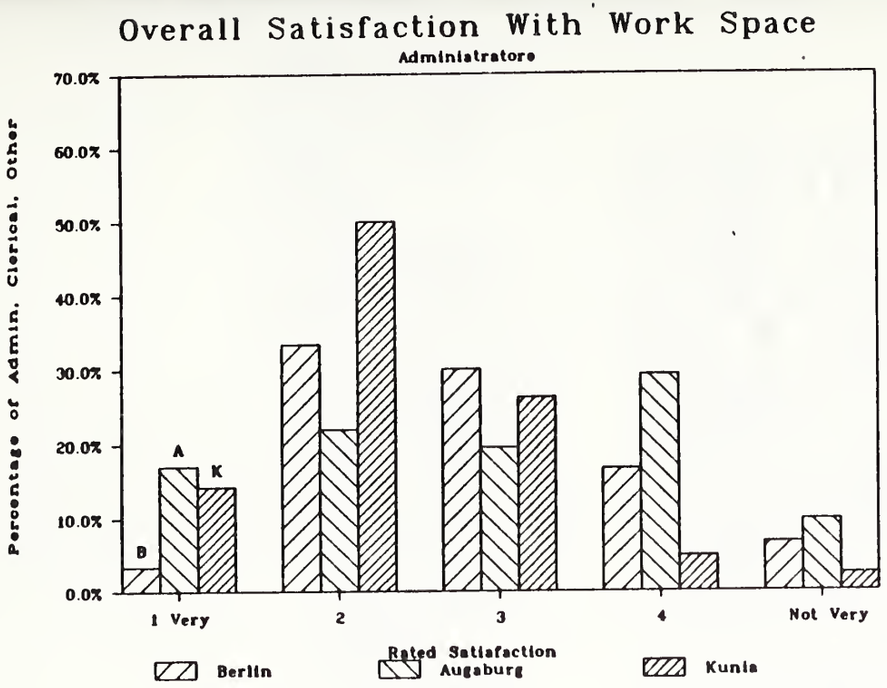
Augsburg:
The space is not apportioned properly. The rule of thumb is that if you can acquire space you do it, in a sort of "lebensraum" type maneuver. The speaker has one 4-drawer safe so he has to use the computer for storing information but that's not up 100% by any means. There are six piles of material on his desk that he'd like to get rid of. Do analysts like clutter (as has been alleged by other non-analysts?) He says no, but they don't have enough storage area for things they need. When you are doing shiftwork, you need to leave a clear trail for the analyst who comes after you.

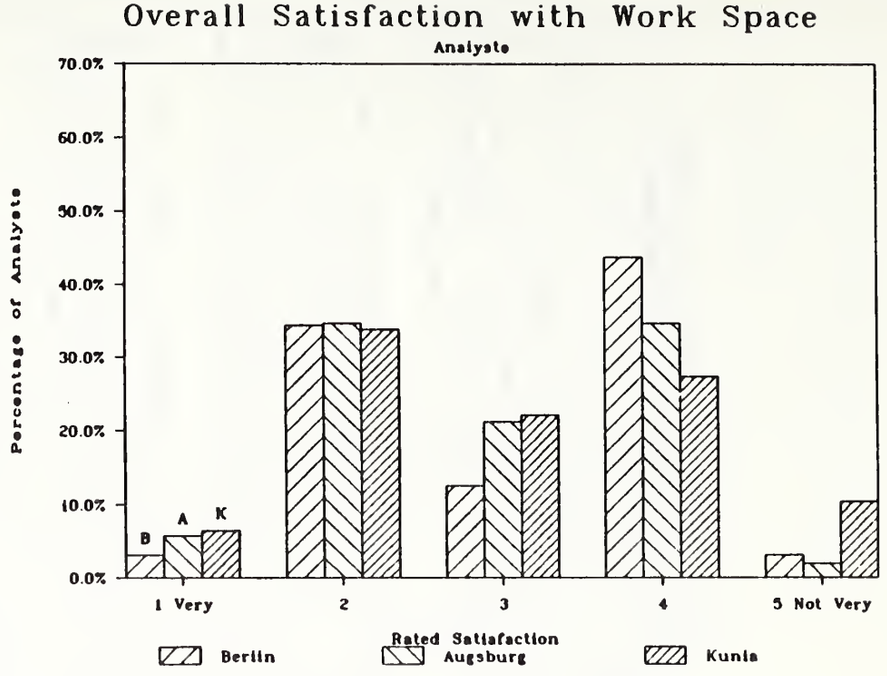
The analytic work is also performed in an open setting, with the workers afforded no privacy or separation from one another. This type of activity, which requires considerable thought and concentration, in other settings usually merits separation from potential sources of interference.

4.4 Space

With missions expanding and new equipment being installed continuously, the need for additional space was a common issue. The fact that planned expansions to the space have been delayed, particularly at Kunia, has intensified the concern. The fact that analytic and administrative areas, where space requirements seem to be greatest, are furnished with old traditional desks and file cabinets has exacerbated many problems. These furnishings are not appropriate for many of the VDT based tasks now prevalent, and can waste considerable space. Another factor that adds to the crowding problem is the presence of obsolete and often non functioning equipment.

As for space in the analytical area, people are back-to-back with no spare room. Space is a critical issue with more and more people being crowded into less and less space. Spacesaver desks might be useful as might some type of systems furniture. There is a real need to think vertically rather than horizontally. Using workstations might well be a better way of using space. They need typewriters, desks, and diskpacks to be immediately accessible, but some, less frequently used material could be stored over the desk.





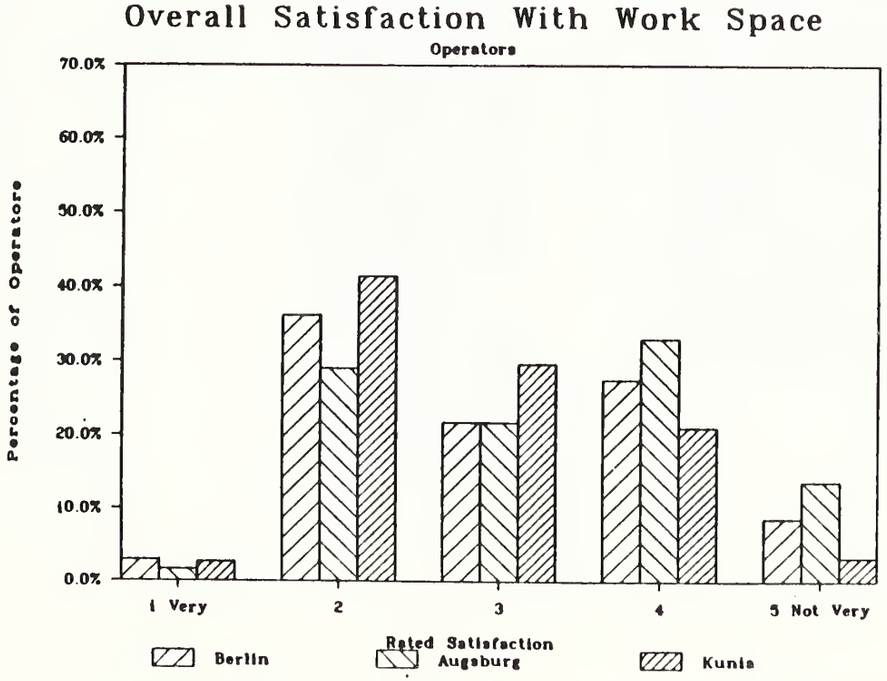


Figure 6 Information on the Overall Satisfaction with Space at the Different Sites

Comments *from the Occupants*

Augsburg:
Things are stacked up, hard to find. Nice shelves would be more congenial. The areas being so closed in gives feeling of imprisonment. Increase storage area for working aids, etc.

Kunia:
More surface space to work.

5. Furnishings

The current environments in many of the workspaces at the three sites give the impression of cumulative ad hoc decisions over many years. The lack of file storage and working desktop areas was a major source of complaints at all field stations, especially in the analytic areas. Much of the furnishings are antiquated government issue materials, unsuitable for many of the electronic based tasks that are so prevalent in these environments. Since space is often at a premium at field stations, its proper organization becomes extremely important.

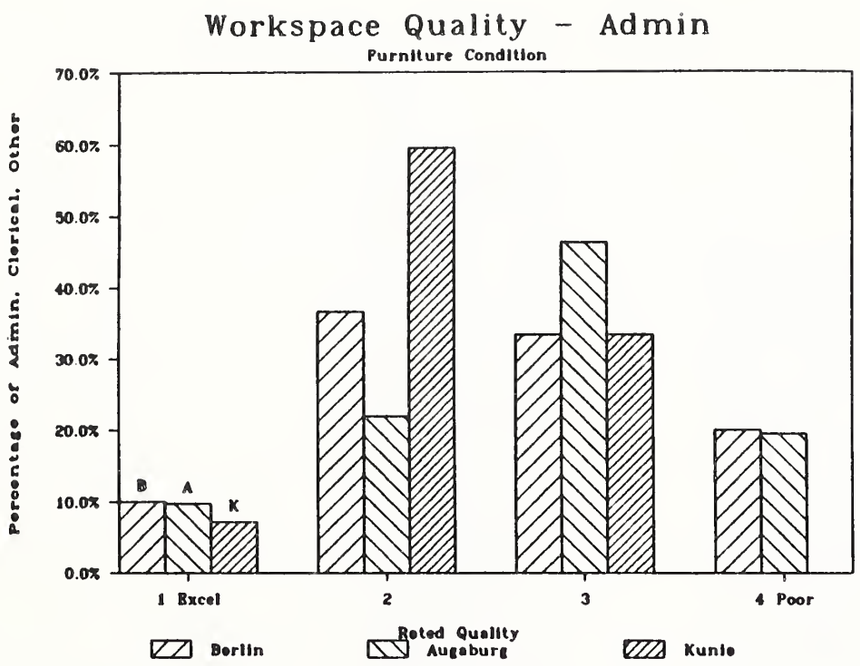
Systems furnishings could be installed for more effective use of space that is actually available but is currently cluttered with large, nonfunctional, traditional desks. Storage is practically non-existent with paper reference material in boxes because there are no file cabinets and printers occupying space on top of the few file cabinets.

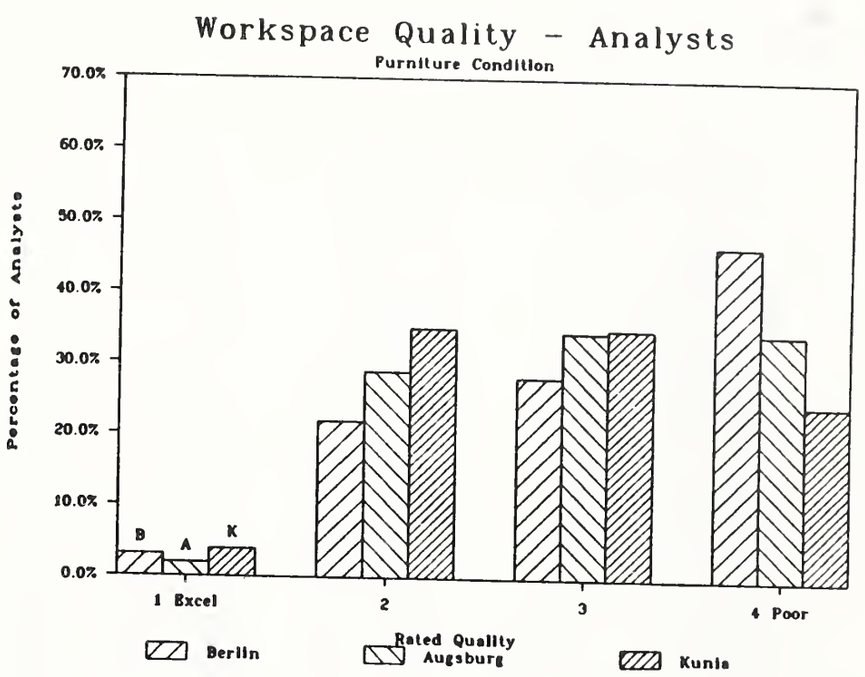
In too many instances, furnishings, especially chairs, are old, in disrepair, and not suitable to the jobs performed. Inadequate chairs are often unsafe, make the job more difficult, and add to the unsightly appearance of many areas within the field stations.

The chair problem reported at Kunia (Rubin and Collins, 1987) exists elsewhere, as well. As one person put it during an interview,

> *There is always a battle of who got my chair at shift change. It's a dynamic struggle. The chairs break easily, and the backs come off so that the operators are sitting on a stool with a stub sticking up that jabs them in the back. The last man in gets that chair until it's shuffled off. Are they adjustable? They're supposed to be, but not all work. Parts are frozen, gears are stripped so you can't change the height. There is a need for a high quality chair which is durable and can be adjusted.*

Figure 7 presents data on the perception of the overall furniture condition, which indicates that administrators at Kunia are the most positive, while analysts at Berlin are most negative about the overall condition of their furniture. Figure 8 presents data on the perception of the ability (or lack of ability) to adjust the back of the chairs. This figure indicates that most of those questioned feel that the ease of adjusting the chair is poor.





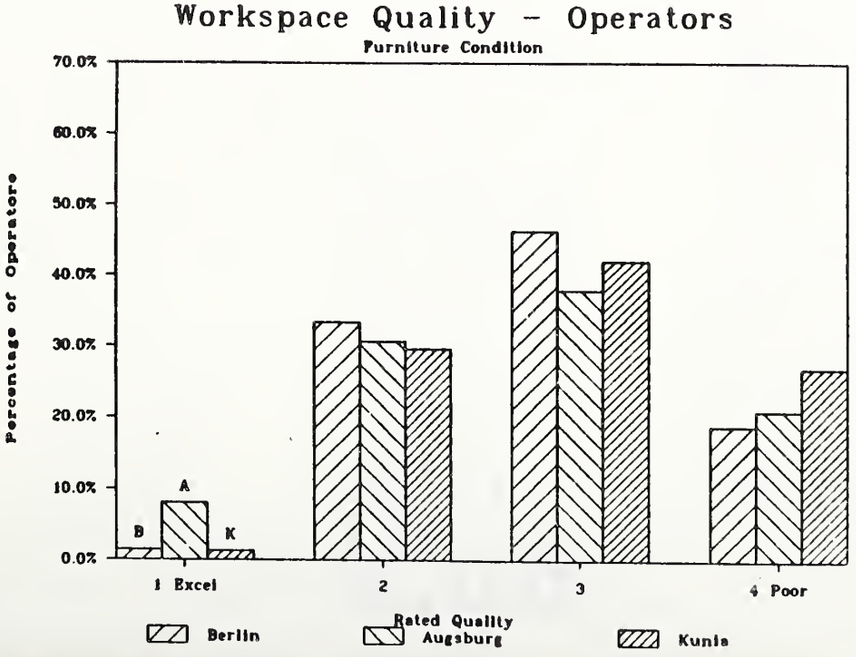
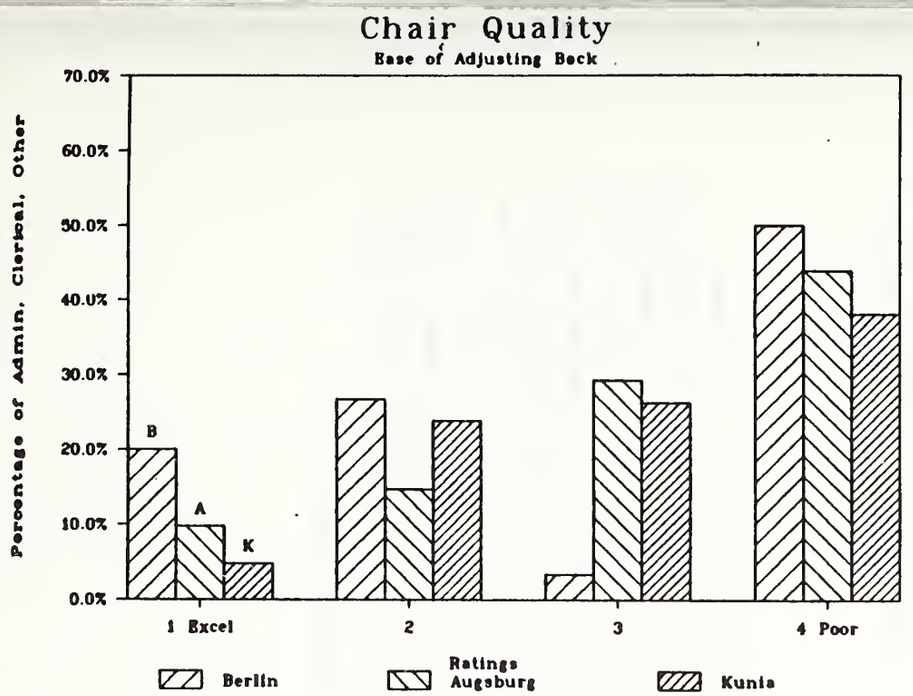
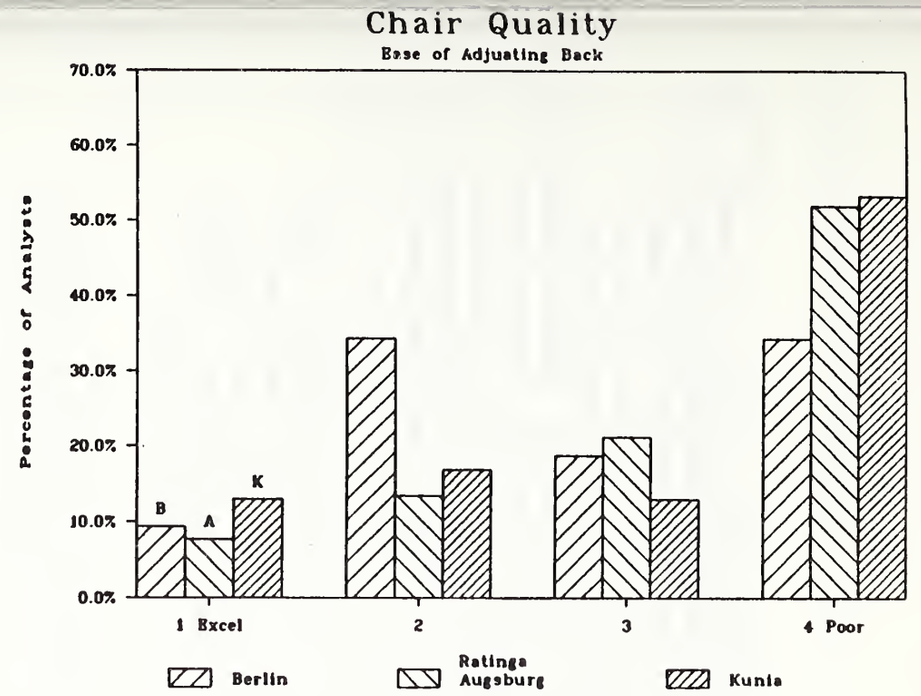


Figure 7 Perception of Overall Condition of the Furniture at the Three Field Stations





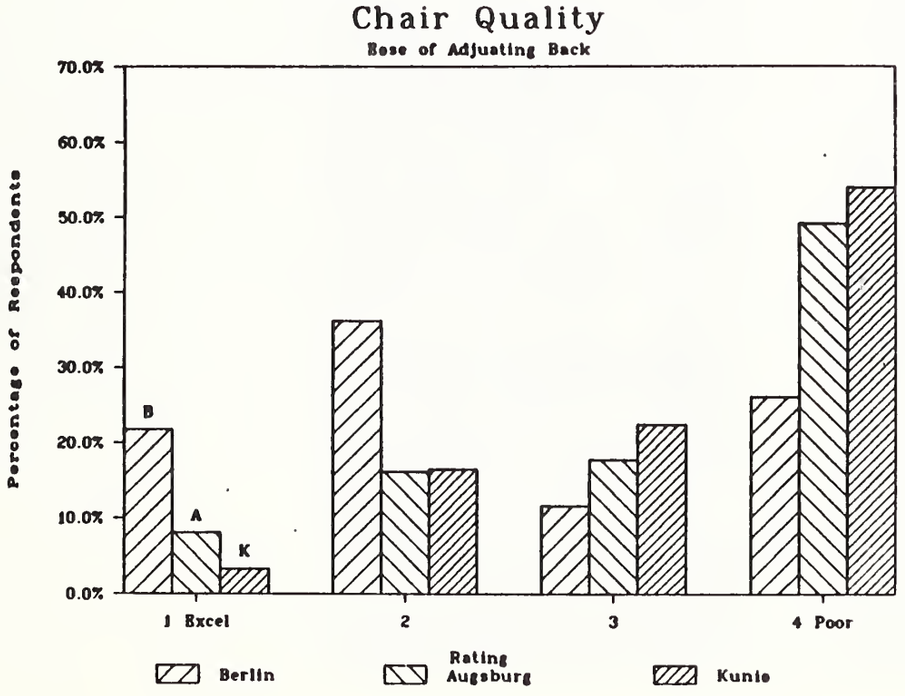


Figure 8 Perception of the Ability to Adjust the Back of the Chair for Support

Comments *from the Occupants*

Augsburg:
Our desks are WWII vintage and the drawers don't work. I have to kick the drawer to get it to open. You can't get a computer table to save your life. They have changed the battalion, shifts, space but things still don't work right. The speaker has two computer tables that took 6 months to get. The furniture is given and you can't get new furniture easily. The impact on the job is serious. There is not enough safe space so they will put files in boxes, which slows you down because you then can't find it. Everything is time sensitive reporting. You can't meet deadlines anymore with people on details and unable to find working aids and computer down time. It all makes things slower than they should be.

Old gray government desks should be replaced with work stations. More table space is needed to lay out things/more storage space required for working aids. Metal furnishings are as depressing as they are beat up. New chairs are needed to relieve neck and back strain, tension. Current racks are not very comfortable; the bookshelf is too high to reach.

Berlin:
The chair is very uncomfortable and needs padding, contours so one can sit properly. More shelves are needed; get rid of big, good for nothing 19th century desks.

Kunia:
Get a chair that is adjustable, with arm rest and back supports. On some chairs you can adjust the back, but it's like lying backwards. The back is not firm enough. The chairs need to be height adjustable. Some people are 6-7 ft tall while others are shorter. Some want their feet to just touch the floor while others want their feet firmly on the ground, still others are in the middle.

5.1 Carpets

Although carpeting is present in many areas of the field stations, it often is not properly maintained. Another major problem is the lack of uniformity. Often, several different types and colors of carpeting appear in the same area. Typically, the seams are held together with duct tape or left unbound. Such carpeting has often been obtained by individuals on their own initiative to cut down noise and improve their office's appearance. Unfortunately, there is little overall control of quality or concern for appearance. Maintenance is a sometime thing and is often inadequate. In some areas, carpet tiles are being used, with mixed results. While they can be removed when worn or stained, this does not always happen. Replacement tiles often do not match the original color exactly, giving an overall checkerboard appearance.

Comments from the Occupants

Augsburg:
The carpeting is dirty and patched in many areas, providing tripping hazards and an unsightly appearance. The analytic area is unsightly, crowded, has old carpets, is noisy and generally depressing.

Carpet tiles are easier to maintain and replace than carpets, e.g. spillage of coffee - replace tile, cannot replace entire carpet, results in unsightly mess. There are problems with carpet tiles; fibers can get into equipment. Quality is important, specifications guided by traffic; cleaning is another problem, dirt is swept and gets into equipment, vacuum is seldom used. The sub floor must be kept clean; a good deal of dirt ends up there. The new area of 2000 sq ft, with carpet tile is holding up well after several months of use.

6. Workstation Design - Physical Features of Operations

The size and configuration of the individual workstations in the operational areas are dictated by the equipment used by operators for monitoring and other required activities. The workstations are abutted against one another, with minimal room for anything but the materials being worked upon at the moment. No personal items were evident, intensifying the factory-like appearance of the setting.

Figure 9 presents data on people's ability to personalize their space at the three field stations. This figure indicates that the operators at all 3 sites feel that they have little wall or desk space for personal items.

All activities other than administrative and some supervisory functions were conducted in open space areas, without panels or other dividers between operators. The conditions appeared to be quite crowded, particularly at Augsburg and to a lesser extent at Kunia. As noted earlier, the Berlin operational area was in the process of being renovated, so that some of the problems related to space had been solved.

Comments from the Occupants

Kunia:
Let operations personalize space with posters, etc.

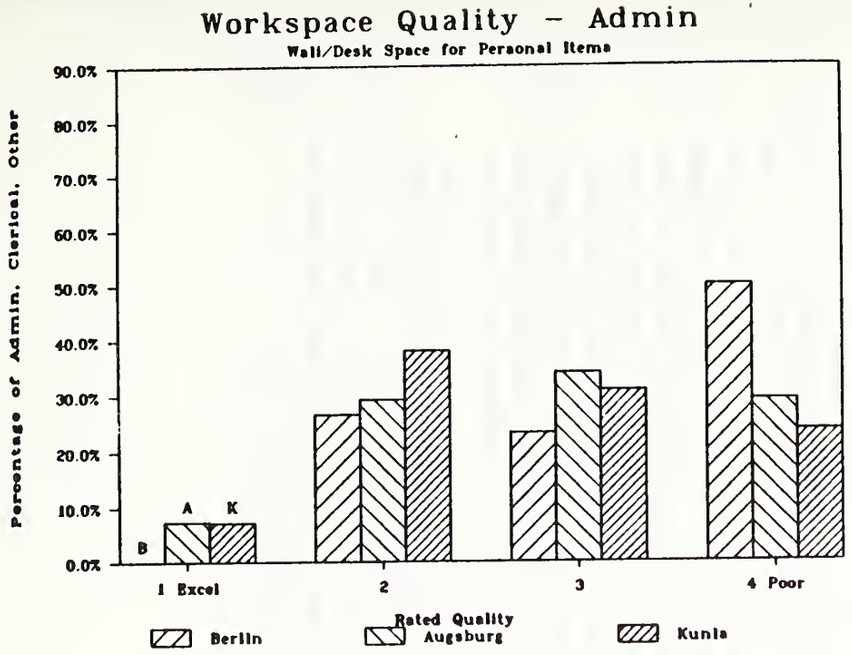
6.1 Equipment

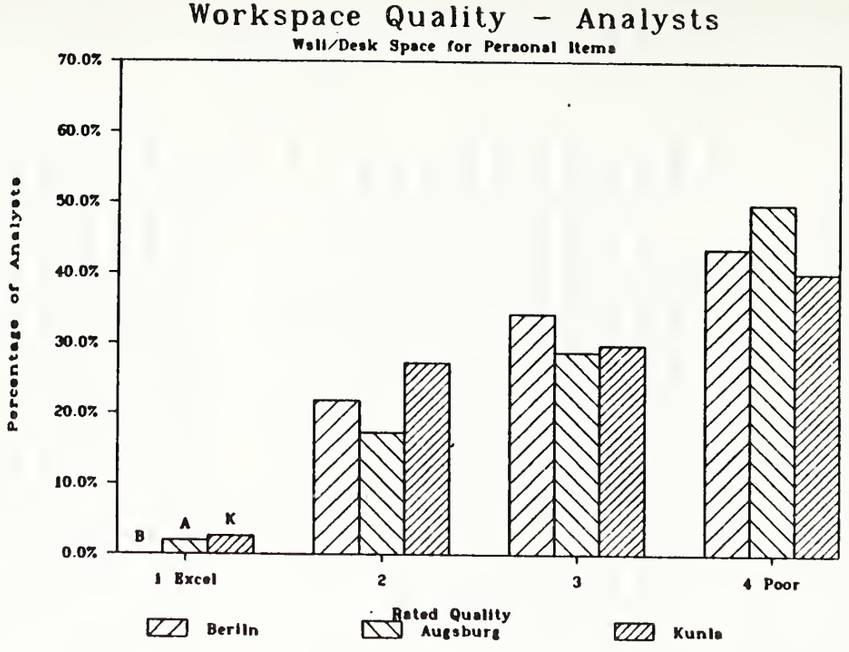
The equipment used to obtain aural information provides the opportunity for the operator to fine-tune, but if the optimal signal is embedded in noise, the procedure is to listen to it repeatedly until the maximum information is extracted. This is an extremely time-consuming procedure, and a frustrating one in that progress is very slow. Throughout the study, numerous negative comments were made about the functioning of equipment, indicating that it is a major source of concern to the people who believe that it keeps them from doing a good job.

Comments from the Occupants

Augsburg:
Get better equipment or equipment that works more than 50% of the time. Replace everything with more modernized equipment. Bring in the new equipment you have been promising for the last 5 years. Get a new computer system and start from scratch. Get a system other than monopole that won't crash every 10 minutes. Get new equipment or fix old equipment. Find a better computer system/replace ancient terminals with up-to-date equipment.

Keyboards are too high. I get cramps in my shoulders from awkward position.





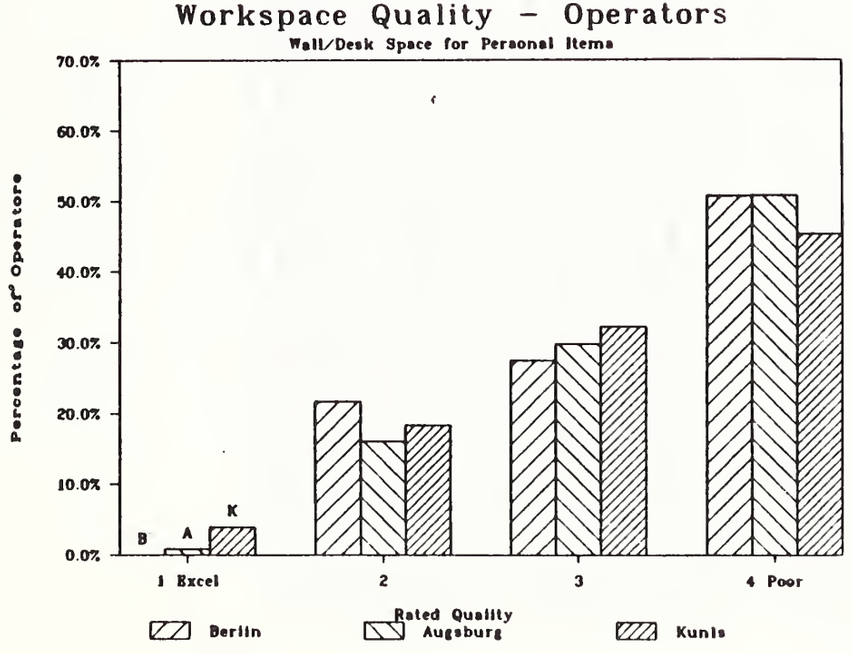


Figure 9 Data on People's Ability to Personalize Their Space at Different Locations in the Three Field Stations

Berlin:
Still working with punched cards, obsolete!
Maintain backup equipment supply; avoid 6 month wait for important equipment. Get something that works. Make it more reliable. Get a computer that works for more than 5 minutes per day.

6.2 Systems

The current systems are complex, difficult to operate and maintain, and require engineers to keep them on line. Equipment adjustments must be made continually. Also, interviews with operations people revealed that equipment reliability is quite low. The operator survey conducted as part of this study reinforces this view; a large proportion of operators indicated that down-time of equipment is very high and that they need better equipment to work effectively. Many difficulties can be attributed to the way in which equipment specifications are now written, by engineers working in an 'ivory tower', with no feedback from those using the system.

Comments from the Occupants

Augsburg:
We have a computer room which is projected to support basically the same organization with 15 different computer systems. They are intended to talk together eventually. Right now 1-2 talk to each other. There is a great deal of need for communication. An operator may need information from system Y but system X won't talk to Y so he must find a terminal which supports Y. But there are only five in the station so he must leave the operations area and find it (and someone who knows how to use it).

If an analyst wants to get last year's data, he must run downstairs and get a tape loaded (and find someone to help him). If he wants to find a valid data base, it will be a five minute walk to find the system.

For example, an analyst upstairs writing a report has collected the needed information and is now putting together a final report. He has many working aids ranging from hard copy to the computer system. He decides something is on system Q and P which are connected back to headquarters. To access the local and headquarters databases, the next nearest terminal is on the first or third floor, at least a five minute walk. Because it's such a hassle to find a spare terminal it often isn't done; and the quality of the final report suffers. But when an analyst wants to look at historical data, most of it is on tape. To log on, he must talk to a programmer to load a special tape if the data are older than about 45 days. It could take 1-1/2 hours with luck. But the computer specialist is often working on a report to go out. He can't waste 1-1/2 hours looking for a tape. This destroys concentration (with start up and wind down time) raising the frustration level.

People must learn so many different automation procedures just to get on the systems; passwords, operational systems, logons, etc. It is impossible to master all systems. Most master just the main one. It takes an analyst 3-4 months to work the simplest system or 1-2 months to be functional as long as someone is by them. Most people come in with a 3 year tour. After 2 months they are functionàl on the job on the floor; 4-5 months later they have mastered the basics. About that time they have heard about other systems, and say "I want to see if these others are what I've heard about, and will help me do my job". This individual will start going to other people asking what can be learned from systems P,Q,Y, etc. After about one year, they've experienced so much frustration they just quit looking. The best and most motivated people get very frustrated. They do only what has to be done. They quit doing anything extra or innovative - just fill out the forms and quit thinking. An individual gets tired of climbing mountains.

I've always thought that operators should only enter data once. You've got to make a 20-year old system talk to the new system and integrate the different machines. Even with compatible hardware there isn't compatible software. It took IBM 5 years to put the main system together but many people have had to work extra hours developing a tremendous amount of source code.

In generating specifications, different people are working out there. Sometimes people do specify interface needs. There is no central office. Project managers are on station but don't have details. People in the States have no idea of what's useful. Lip service is paid - they do site surveys but very few people are capable of doing capacity evaluation because they have very little automation background in system selection, installation, and capacity management. Also when given a project it's one that somebody else has dreamt up and so the interdependencies and relations get overlooked in INSCOM.

Systems go out and they're not quick procurement actions. It may spend one year in planning, going to procurement, and to the RFP. The person who wins the contract to build the system at his own facility - that takes another year. So there's a minimum of 2-1/2 years before something shows up on site and so it's obsolete by the time it reaches the site. It's been at least 2-1/2 to 3 years after the idea was initiated. The people who had the idea are gone by then. The force that caused thing to happen has built up over 3 years. They bring something in special to deal with the problem of 3 years ago, but the problem size has increased. The work load is heavier or shifted in another direction.

The current system affects the overall productivity and quality of the product. If a person leaving here after 3 years goes to another field station and sees same system with few differences, he would be functional the day he walks in the door. He would have 3 years of experience. Now, people have it only if they request re-assignment to the same field station. The logistics systems now all run on Honeywell systems so

logistics people can move from place to place. With 3 years on the job training, people function at 5-6 years out of 10. Our people are the cream of the crop and are highly motivated and make the real best of a bad situation. The net effect, however, is that for every field station tour a person is only productive for 2 of the 3 years. In a limited number of instances field stations use the same equipment. This cuts down on the learning curve. There is a need for people to be competent and have on-going training. It is better to cut out the learning differences between the various systems at the field stations. It is better to learn stuff relevant to the job and then learn how to use tools to do the job. This would allow more time to master the job. A good idea would be to develop an army automation MOS within INSCOM, identify people with this MOS and keep them; train and keep people on both army automation and mission systems.

A major problem is that everyone thinks that they know systems, and can make decisions about them - data processing, programming, maintenance. As a consequence a great deal of localized decision making exists, resulting in a variety of 'subsystems' that should work together but are incompatible. This is true for information, data processing, operational, hardware, software, etc.

6.3 Headsets

The characteristics of headsets are quite important both for effectiveness and comfort, especially when one considers that the noise environment is a very poor one for the tasks performed. Furthermore, if an employee spends virtually an entire working day with a headset on, its features play an important role with respect to work comfort, whether this is recognized by the individual or not.

There appeared to be several approaches employed in the use of headsets. At some workstations, there was one type that was used by everyone. In other places, several types were available, and it was up to the operator to select the one preferred. For yet another type of equipment, only one type of headset was compatible, and therefore no variety was possible.

The headsets ranged from being quite light and inserted in the ear canal to those which were quite large and heavy. We didn't have the opportunity to gauge their relative effectiveness as a barrier to environmental noise, but it is generally known that the most efficient headsets from this standpoint are individually fitted and cushioned to ensure a proper seal from outside noise.

A major problem, particularly at Kunia was the noise levels that prevailed within the headset. Many of the operators had levels of 80-90 dBA, in an attempt to separate out signal from noise. Reports of hearing loss were quite common as a result. At other field stations, some equipment redesign had been done to allow operator control over extraneous noise levels. Still, though, operators reported minimal

loss were quite common as a result. At other field stations, some equipment redesign had been done to allow operator control over extraneous noise levels. Still, though, operators reported minimal training in these control systems. This topic will be discussed in greater detail in 7.3.

6.4 Equipment Maintenance

When equipment repair is needed, complex interactions are needed at multiple locations with several people working, often with limited information and inadequate feedback.

Lighting emerged as a major concern for maintenance personnel. Because the operational areas are so dimly lit, at the request of the operators, the maintenance people cannot see to do repairs. They badly need the capability of task lighting to see the relevant parts of the equipment. Often, too, the equipment cannot be moved, forcing one person to work on the front of the equipment and give directions to someone located at the back. The ergonomics of equipment repair are particularly poor.

Maintenance is made even more difficult because some work locations are at remote sites. Repairs are often coordinated with someone at the primary site who can't see what the remote person is doing. At these places, the elevator breaks down often; buildings are high. People run up and down to go from work area to sleep/rest area. Phones are 'open' and messages heard throughout the building; sleep is interrupted; most messages are for people other than those being contacted. It is a very stressful job, and all the running makes it more stressful. Performance is degraded from stress, lack of sleep, movement up and down; also errors increase. Hours are added to the working day. Time could be saved by co-locating work and living areas; having separate communication channels for individuals or at least, locations.

Comments from the Occupants

Augsburg:
A primary activity is reading microfiche; all records are on fiche. Readers are of cheap quality, lighting is poor. When focusing on material, document has to be moved and it's easy to get sick to the stomach during this activity. A major task is looking for parts listed in many manuals. Sometimes it is necessary to spend all day using fiche readers.

Have adequate stock of spare parts so repairs can be done sooner.

Berlin:
Replace old test equipment with equipment needed to do the job. Equipment is old and outdated; Always needs repairs.

7. Job Design

The tasks performed by the various groups, particularly in operations, appear to be rigidly defined and separated from each another. That is, a given person performs one and only one task from the time that work starts, to the end of the day. Many of these tasks are extremely repetitive; the same type of material is examined time and again. Such tasks are quite boring for most employees. On the other hand, the introduction of variety into jobs, even if the alternative task is also a repetitive one, could alleviate this feeling. If some of these activities were under the control of operators, so that they could pace themselves, that would be help in reducing job frustration.

Other activities require individuals to perform their work in "real time". This situation, where the job itself is made more demanding because of the quality of the material they deal with, is one requiring great concentration and skill. The job demands over the space of a workday are conducive to stress as well as likely degraded performance. The lack of control over any aspect of the task also contributes to its difficulty.

Comments from the Occupants

Augsburg:
In my job I use an equalizer to filter out static. I turn up the midrange and reduce the low end. Others don't always use it. I try very hard not to turn the volume up too high. It takes about 5 minutes to adjust the equipment to optimize the voice signal. I taught myself the use of the equalizer. I received one day's of training on the main system, then was on my own. It took 10-15 minutes to learn how to use the equalizer.

Job itself is too stressful. If atmosphere was more easy going, it would ease the job. Lower the tape recorder/put it in "reasonable" reaching distance.

Berlin:
Need off time to relax. Put equipment within reach and closer together. Fix position to best suit operator; rearrange equipment. I have six different phones on 4 different desks.

Kunia:
Replace with equipment more suited to operator's needs. There are a variety of irritants in the facility. There are long reaches of space to get to equipment. Costs weigh against human engineering features and changes. It is more economical to rack and stack to save space, yet this is harder on the operator because he must get up and down 20 times or more to reach something on the top shelf. With respect to the timing of human factors input, when performed late, as a retrofit or after thought

it is very expensive. Occasionally as a result of general constraints the human engineering gets lost in the shuffle. As an example, at one of the old consoles it is very difficult to sit squarely in front of it; the operators tire quickly. The screen can't be moved to try to fix the offset problem.

7.1 Ergonomics - Organization of Work

Ergonomics has been largely overlooked in the design of equipment used at the field station. For example, to obtain data operators sometimes must use several systems which have different keyboards, displays, operating systems, and software, while making control adjustments requiring movement from place to place. This is difficult, time consuming, and likely to result in a high error rate. (There is a history of human factors work, dating back almost 50 years that is being almost totally ignored in designing systems.)

In many instances, workstations contain equipment which is difficult to use, sequences of activities which are difficult to perform, and tasks that are incompatible with one another. One example is the requirement to view a VDT while recording information on yellow paper with pencil under lighting systems which are inappropriate and inadequate for either task.

Comments from the Occupants

Augsburg:
Ergonomics are a disaster area. There are no manuals for any of the systems in the area so you can't do preventative maintenance (even though it's a requirement to so do). It is very rare to talk to the operator or analyst in the design stage to determine how equipment should work.

Berlin:
New systems are coming on line. Timeliness and duplication of efforts are a real problem. There is often a need to re-enter information in 4-5 places. It's insane to have to rekey in 4 extra places. There are different keyboards, etc. No continuity. Response times vary for each system with 6-10 sec response times 10-20 times an hour. It causes major problems for the operators and introduces the potential for errors, particularly with fatigue and inexperience. The speaker claimed that an operation that took 3-5 minutes with the old system would take 29 minutes to process with the new system because of mind-boggling slowness and repetition. There is the potential for two incompatible systems working side by side which crash. Operators spend so much time manipulating the systems that they can't do work. They need to learn data processing. The keyboards keep differing. They will need 3-4 weeks training to do the job with each new system. Numerous displays are possible yet they need only a small percentage of them. Need some automation to indicate presence of signal and to revisit signal.

7.2 Information Systems

Many users are novices, who are reluctant to use devices because they are afraid of 'killing' the system. Teaching users is a sometime thing and not a full time activity. Know how is therefore very mixed and changeable, depending on rotation, inclination, etc of the individual user. In addition, hardware configurations differ from one another, terminals and systems can't talk to one another, and software differs, so that the individual's job is made even more complicated.

Comments from the Occupants

Augsburg:
It is difficult for programmers to learn the mission but easier for mission people to learn programming. They have a spectrum of users from those who don't want to program to those who'd like to spend all day doing it. The youngsters frequently are enthusiastic about programming.

They, in the field station keep looking at new products. A primary problem is that many systems are unique, manned by untrained people. One problem is control, since people typically do "their own thing".

The databases are not always available. They are starting to get more timely updates. There is frustration with automation because requests are not always responded to. There is poor feedback to the user who is not told the priority on requests.

7.3 Data Gathering

The one exception with respect to a potential noise health hazard concerns the task of auditory monitoring and analysis. The sound levels employed by operators to collect information are a major source of concern. Although the monitoring equipment available to the study team (an omni-directional microphone) did not permit precise measures at headsets, it was apparent that many operators spend much of their working day listening to sound levels that are likely to cause permanent hearing impairment. Many operators habitually turn up the gain on their systems to monitor difficult communication; those containing considerable noise interference. Interviews with many operators revealed that they believe that their hearing has been impaired by performing this work. Many reported documented hearing losses of 30-50%. Conversations with "old timers" has reinforced this view. It is important to note that the hearing loss can be assessed for specific frequencies by the use of a sweep frequency hearing test. This would allow determination of whether the hearing loss was due to the job or due to off-hours radio/stereo rock music.

8. Organizational Issues

During the visit to each facility, as well as on prior occasions, the study team was told that a hierarchical system existed within the organization with respect to the type of work performed; i.e. jobs at workstations and those at desks. It appeared that the people performing these separate activities were essentially isolated from one another, although only physically separated by a few feet. There seems to be little attempt to provide the opportunity for the people in the two activities to get together and exchange views. If this is desirable, then it would be an important reason to provide common spaces, such as break areas, or even conference rooms, to facilitate such exchanges.

Comments from the Occupants

Augsburg:
The analysts should work with the operators to provide real-time support. The separation causes a wall and decreases mission efficiency. There is a lack of communication. For example, the analyst and operator terminals can't communicate with each other. There is no telephone in the bay. Information doesn't get looked at because not enough bodies and because it's difficult to communicate. It's an "Us and them syndrome". They don't understand the reasons for tasking changes. They need more liaison.

9. Personal Issues

9.1 Training

Many tasks performed by operational, administrative, analytical, and maintenance personnel consist of activities they have not been trained for. On-the-job training is widespread but not always as effective as it might be since it often lacks depth. In addition it takes time away from the mission.

9.2 Morale and Motivation

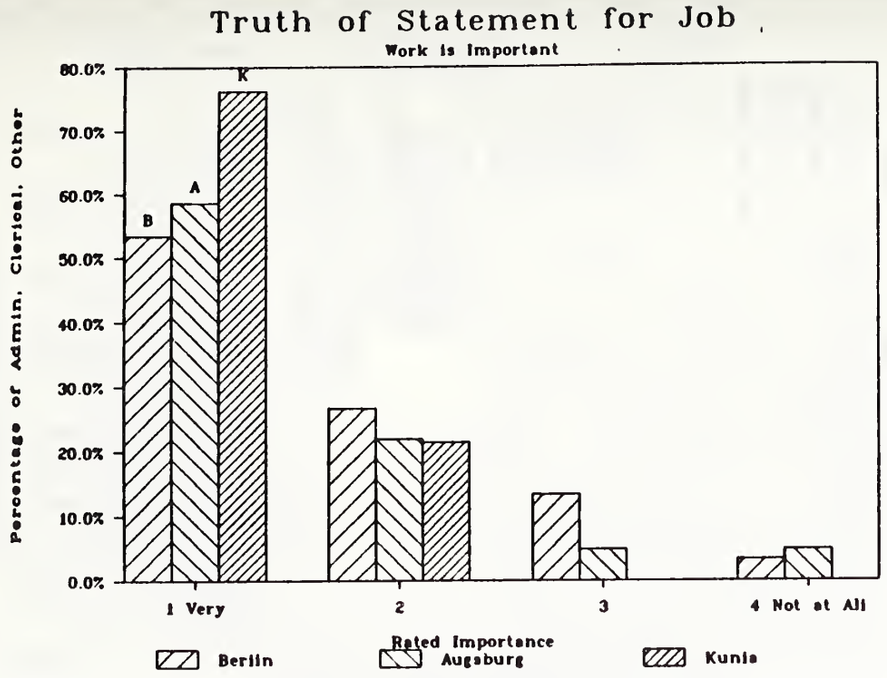
The interviews and questionnaire findings indicated that the staffs of all the field stations were highly motivated to do the best job possible. They know they are performing very important work and their frustrations center on the inability to do an even better job. Many of their complaints were directed toward their equipment and its frequent breakdowns. Other complaints were directed toward "military" activities that they saw as interfering with their jobs. More than 85% of those surveyed saw their job as very important and demanding a high degree of accuracy.

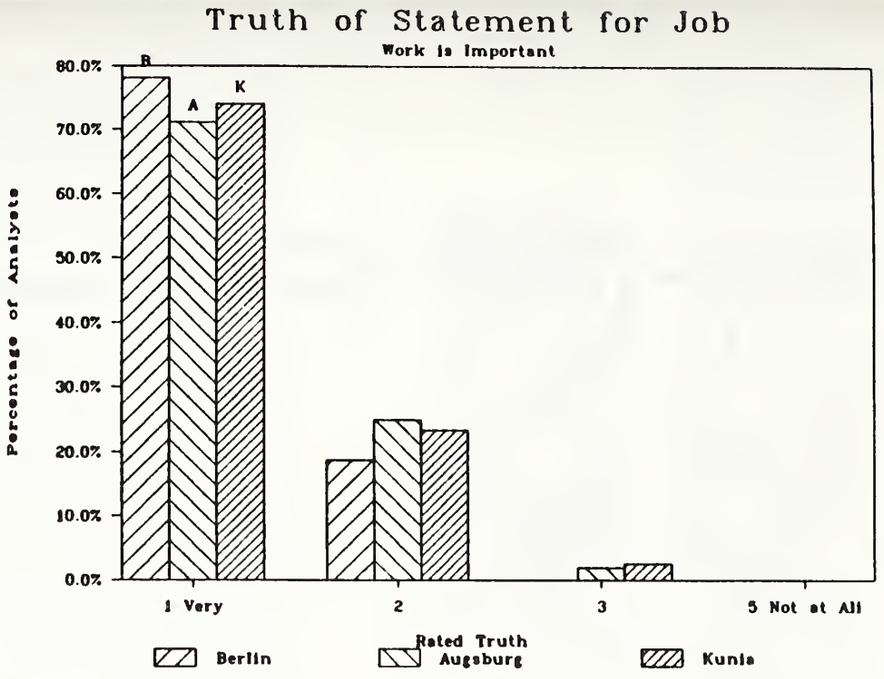
Figure 10 presents information on people's attitudes toward the overall importance of their jobs, while figure 11 presents data on their feelings about the need for accuracy in their work. Both figures indicate that the vast majority of those questioned feel that their work is very important and that it must be accurate. Of interest is that the analysts who were quick to criticize their working conditions have the highest percentage of people feeling their job is important - over 70% think their work is very important.

Comments from the Occupants

Augsburg:
It is frustrating when equipment failure prevents you from doing your job.

Berlin:
I have been in Army automation for 18 years. I expected to work at the leading edge of automation technology. It is 10-12 years behind other Army systems. They are procuring a 4300 series IBM - which has just been withdrawn from the commercial market. Our latest system uses machines in commercial use 15 years ago. It takes 15 years to get something in procurement".





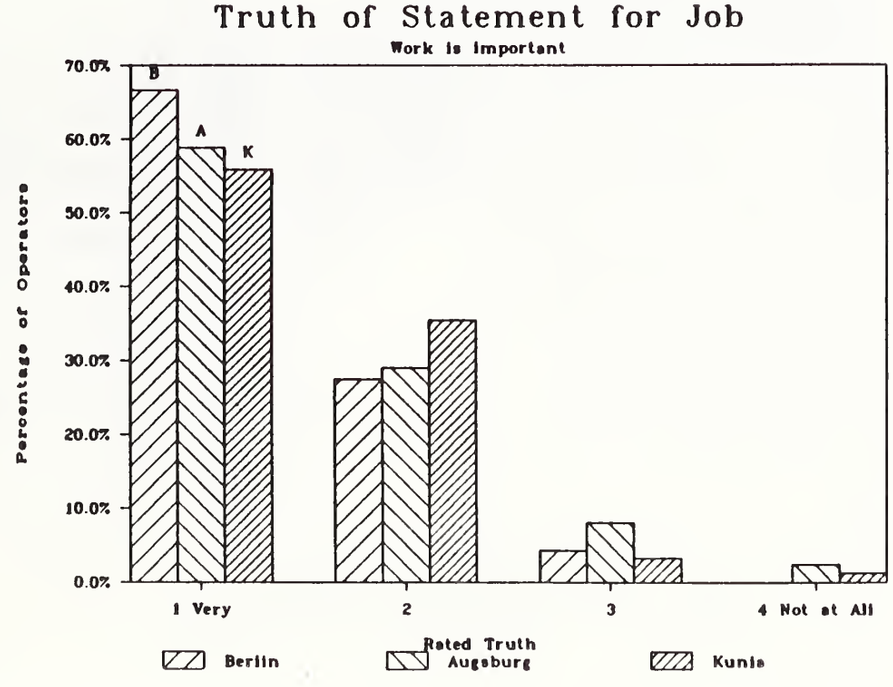
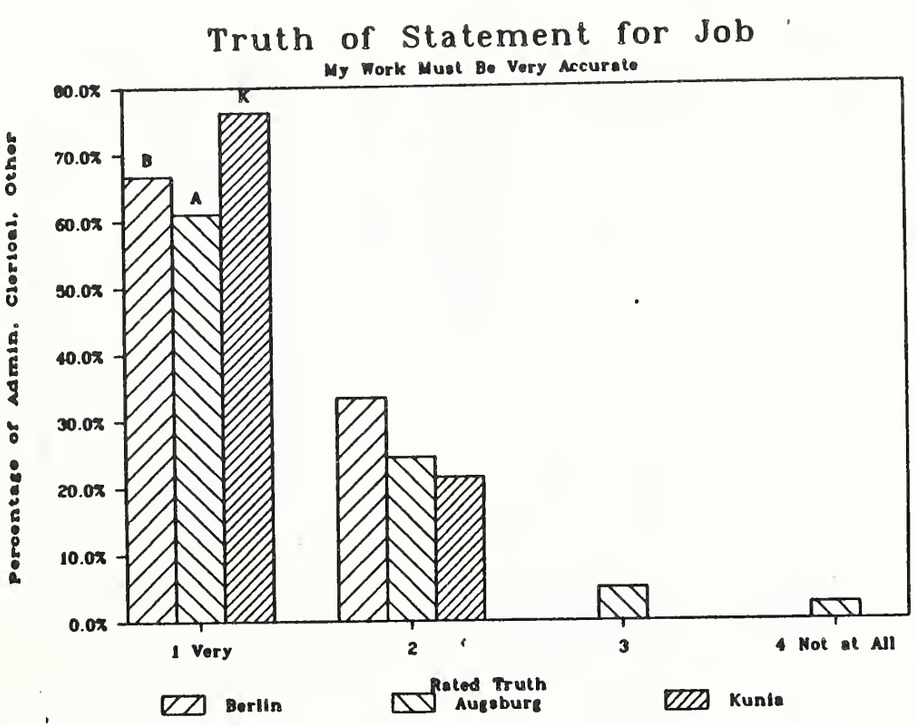
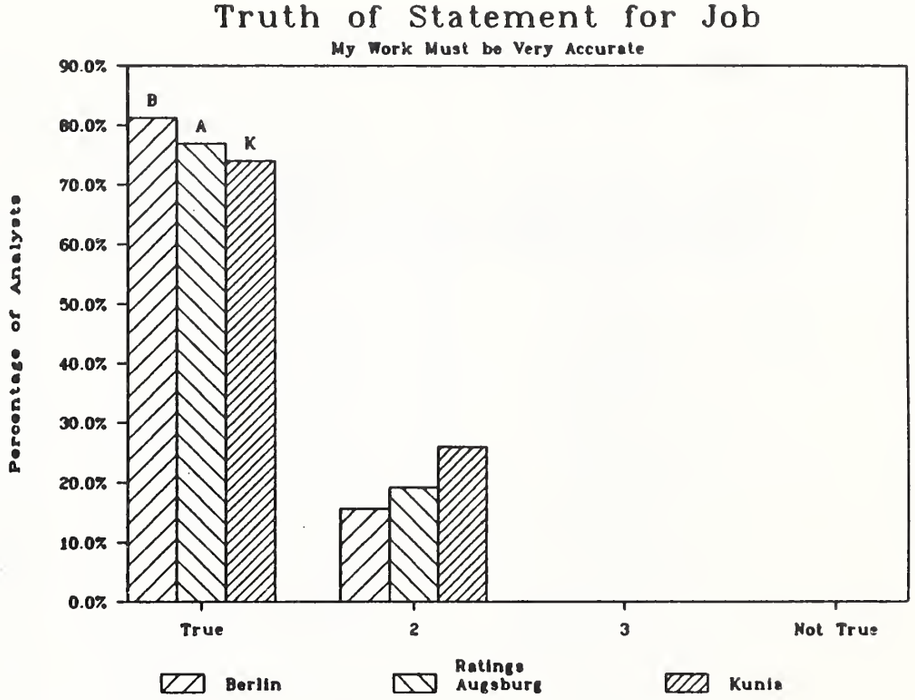


Figure 10 Data on People's Attitudes Toward the Overall Importance of Their Work at the Field Stations.





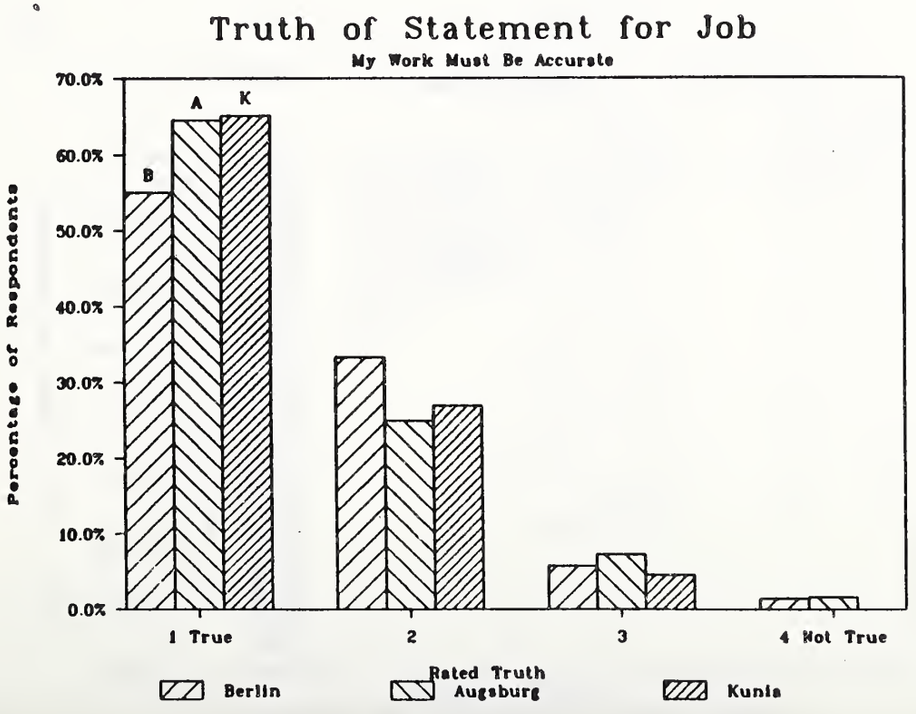


Figure 11 Data on People's Feelings About the Need for Accuracy in Their Work

As a technician it is frustrating; your ability to progress professionally is retarded. You're not learning. I am the manager for a support system which maintains a database for a particular operations. It summarizes the day's activities and provides specific information. This system should allow historical data to project future trends. The system is old and often down. It doesn't work because:

1. *The memory capacity is too small;*
2. *Its ability to support peripheral devices is too small (it can't support enough terminals and enough locations to do the job; and*
3. *It's such an old piece of hardware that obtaining parts is an "absolute nightmare". If it goes down, you're down for days and weeks rather than hours.*

9.3 Shift Work

The scheduling of shift work - typically days, swings, and mids - has been the source of many complaints, studies, and alterations. From time to time, changes in the way the scheduling is done have been made for each individual field station. While many preferences were expressed about shifts, the data indicated that there were almost as many different suggestions as respondents. Little agreement was apparent other than the suggestion that people should remain on a given shift, particularly mids, for about a month when the change was made. People agreed further that changing from one shift to another, rather than being on a given shift, was particularly disruptive.

9.4 Smoking

The smoking regulations are established by the commander of each field station, and the practices differ considerably from place to place. For the most part, smoking was permitted only in designated areas, and not on the operational floor. What was apparent though was that smokers and non-smokers wanted equal treatment with respect to access to and the quality of break areas (when they are separated). Smokers often felt that they were discriminated against, while non-smokers felt that they did not get the break areas that the smokers did. The quality of the smoking break areas were often abominable - with no extra ventilation to get rid of smoke. Smokers also commented that they would be more efficient if they did not have to leave their workstation to smoke, while non-smokers complained bitterly of smoke in the few areas that still allowed smoking.

Comment

<u>Berlin</u>:
Don't make me feel like bad person because I smoke; the smoke room is crummy.

9.5 Privacy

The need for privacy was most apparent for supervisory personnel who have to counsel their staffs and for the analysts as a group. The analytical areas were typically very crowded, noisy, and provided few spaces where people could "think quietly". Because of the nature of their job responsibilities, this lack of privacy is thought to adversely affect their work. Similarly, supervisory personnel commented on the difficulties of advising and counseling people in open areas where everyone can hear what was happening.

Figure 12 presents data on the desire for visual privacy, which indicates that most analysts believe that they have very poor visual privacy, along with administrators in Berlin and operators in Augsburg.

Comments from the Occupants

Augsburg:
Most people work better in semi-private offices; so add some partitions. With so many people in such a confined space, noise makes concentration difficult. Analysis requires concentration.

As a manager I need private space to counsel my subordinates
We are crammed in like sardines; it makes it hard to work with others and is stressful. With so many people you're privy to everything that goes on. There are too many conversations.

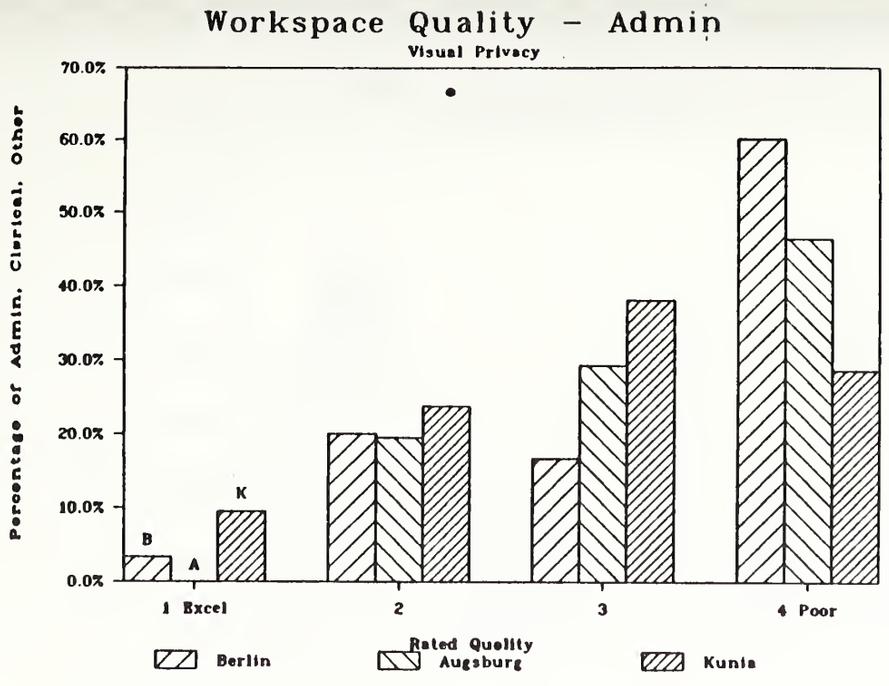
Berlin:
There's always someone around to hear or overhear.

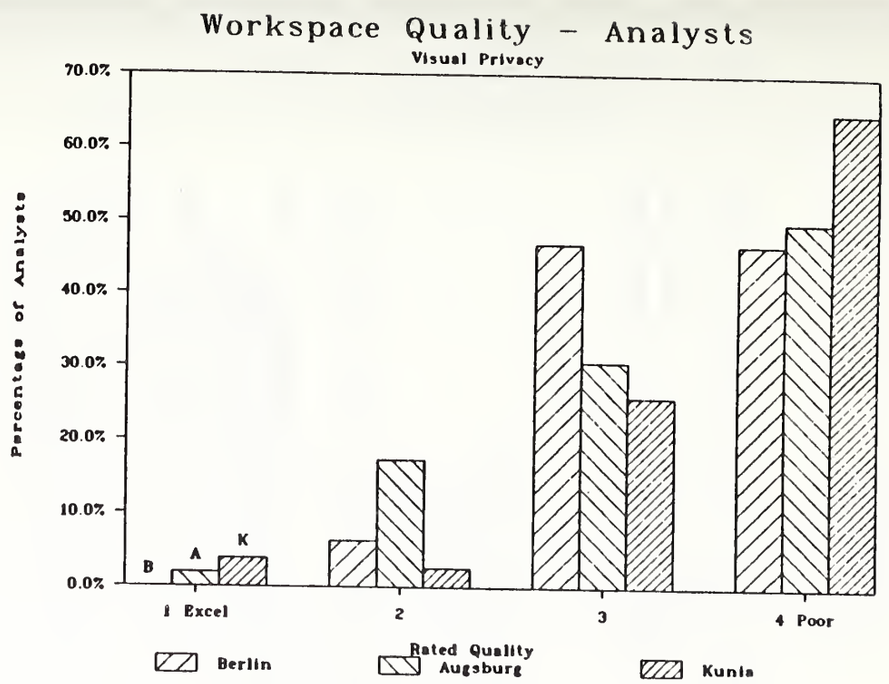
Kunia:
I need a place to counsel my staff and have personal conversations. Install partitions to provide some separation between people.

9.6 Isolation

The windowless settings at the field stations contribute to the sense of isolation felt by many workers. These settings are so different from typical work environments that they are likely to contribute to the overall stress of working conditions. The problem is intensified at Kunia because of the difficulty in getting outside (a ten minute walk), being underground in "paradise", and the many environmental problems present there. Photographs, paintings, colored graphics, murals and artificial windows were used to introduce some novelty into the environment in one work area at Kunia.

Figure 13 presents data on the truth of the statement "I miss having a view out." These data indicate that many of those surveyed (50-60%) miss having a view out.





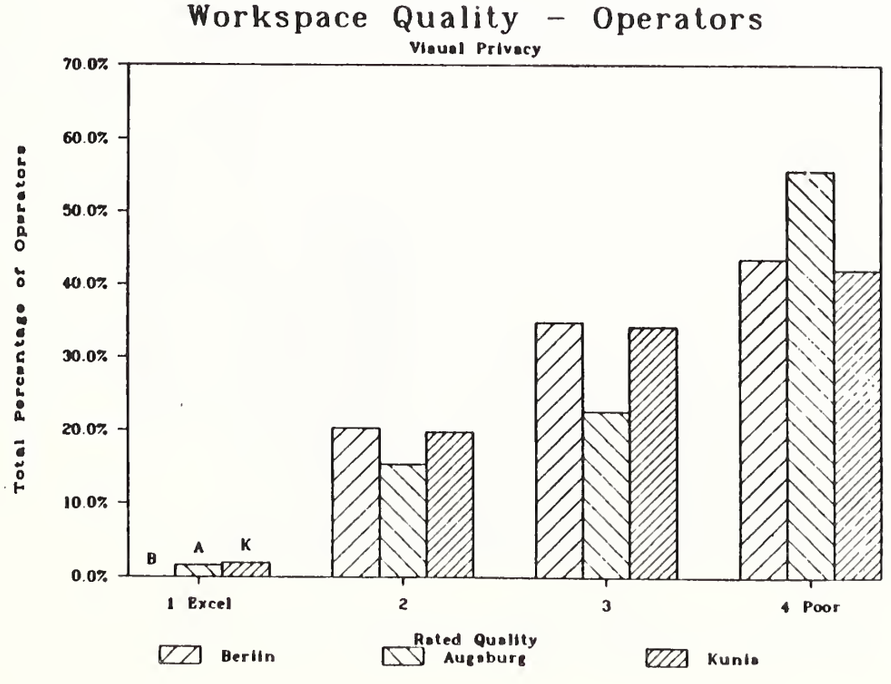


Figure 12 Data on Attitudes About Visual Privacy at the Three Field Stations

Comments from the Occupants

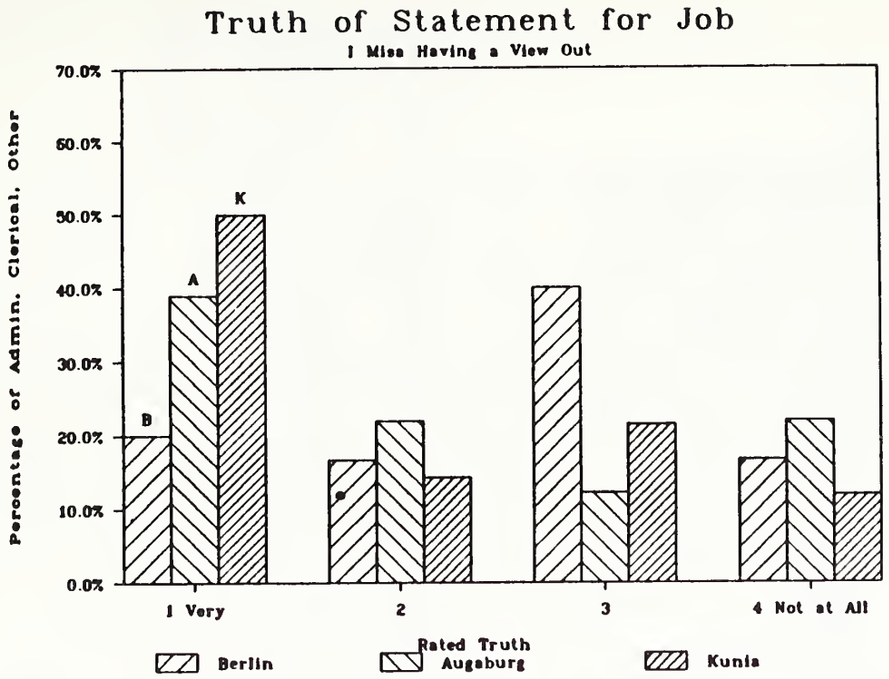
Augsburg:
Don't see outside except when we come in; never know about weather. Need something "different" to look at while confined to a chair for 8 hrs. I hate being confined without a view to the outside world. A simulated view out would make working more pleasant and tolerable. It would be more relaxing to be able to go outside.

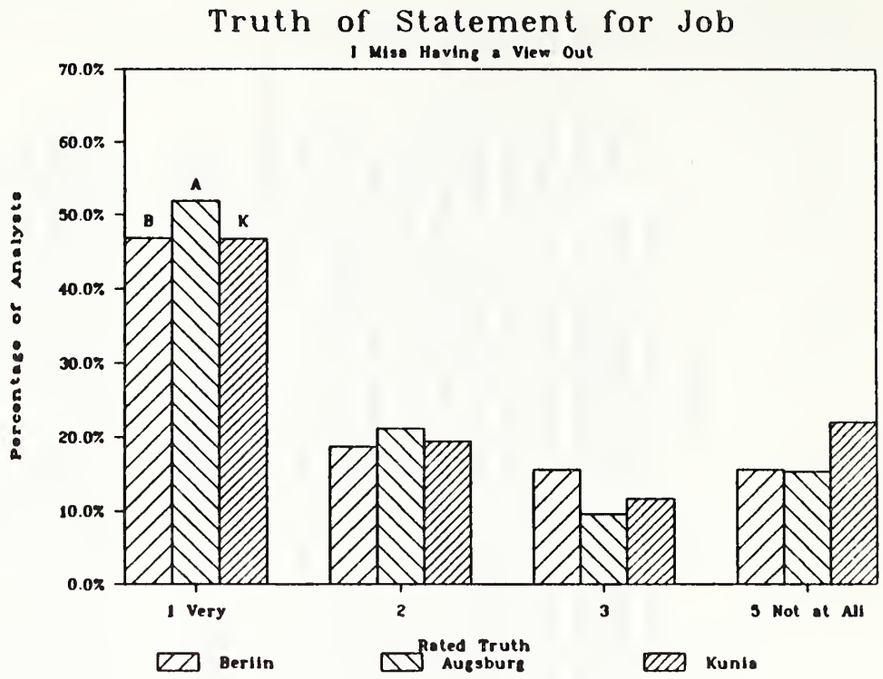
Berlin:
I think a few paintings or pictures will ease tension some.
Need something to look at besides equipment and people.

Kunia:
Access to outside could relieve tension - best way to get away from job.
Being able to walk outside relieves claustrophobia.
A sense of isolation from the outside prevails. Environment is too closed in; it results in stress and tension buildup.

Walking into tunnel is like walking into a morgue. Paint wall with murals/color.

Most buildings have places where it's easy to get outside. It's a quarter mile walk to the outside. I feel the need to get outside at least once a day.





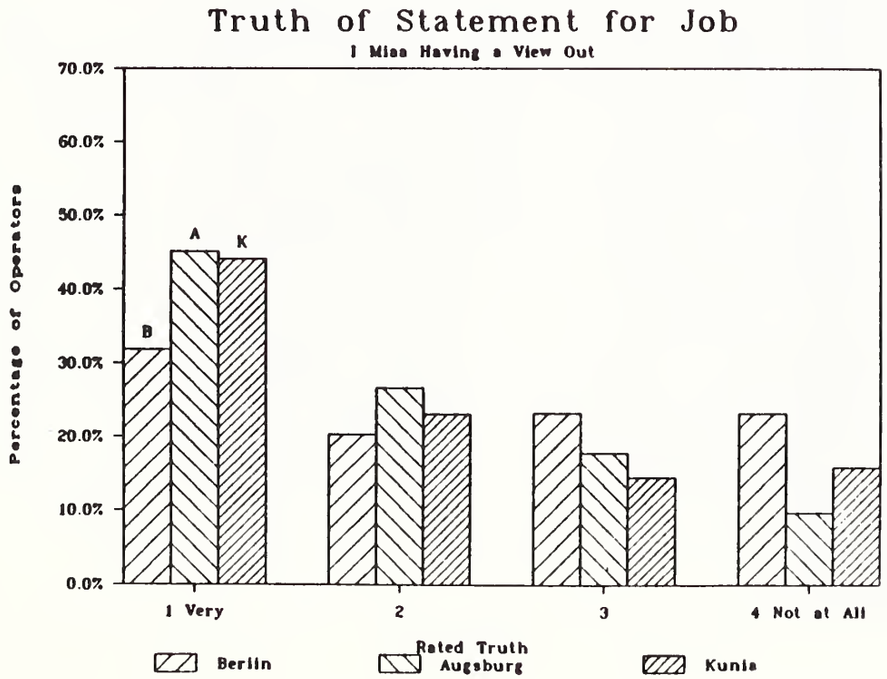


Figure 13 Data on Desire for Having a View Out

10. Planning and Specifications

10.1 Equipment Specification Process

Observations of the working environment, personal interviews, and the questionnaire survey suggest that the systems, both operational and administrative, used at the field stations are difficult to use, maintain, and upgrade. The orientation for procuring such systems seems to be almost exclusively on obtaining hardware to acquire and process information. However, the systems examined are not fully automated ones; rather, they rely on man-machine operations. The fact that people are essential components of these systems does not appear to get the attention that it merits. As a result, operators, maintenance personnel, and other system users are tasked to integrate system performance by skills that they have to develop - primarily as a result of on-the-job training. This is a time consuming and inefficient process. For example, interviewees estimated that it takes from 6 months to a year, a substantial fraction of their entire tour, for them to master their assigned tasks.

A primary reason for the difficulties encountered by field personnel in operating and maintaining their equipment and systems seems to be the lack of communication among those specifying materiel and those using it. In all of our data collection activities we did not encounter any instance where operators or other users had any input to system design (or knew of any formal field station input). Rather, an ad hoc approach seems to typify many decisions, resulting in many of the operational and building related problems identified in the present report.

11. Recommendations - General

11.1 Short Term

11.1.1 Furniture systems

The first step required in improving the furnishings of the field stations is to engage in detailed planning of the various activities performed (and likely to be performed in the near future). The analysis should include consideration of space limitations, likely changes in technology, and the need for interactions among staff members. Standardization of components, ready adjustability, and sturdiness ought to be major considerations in developing criteria for furniture systems. Other important features are the need to facilitate change and minimize the "visual clutter" apparent now.

Recommendations

1. Furniture procurement. Revise Army regulations to institutionalize INSCOM exception to purchasing furnishings.

2. Chairs. In the earlier report by Rubin and Collins (1987), suggested specifications for operator chairs at Kunia were submitted. A number of chairs meeting these specifications were obtained and installed. It is suggested that these chairs be evaluated for durability and comfort as a first step in upgrading the furnishings at all field stations.

3. Pilot investigation. Conduct a limited study, consisting of an analysis of needs, specifying furnishing requirements, and then purchase systems (whether furniture integrated systems or not) to be used for specified activities within the field station. Ensure that "end users" participate in this process. Then, evaluate the system (or several alternative systems) before developing final specifications for the furniture. Finally, implement systems throughout INSCOM.

11.1.2 Heating, Ventilating, and Air-Conditioning Systems

Results from the questionnaire, measurements, and observations indicated that the temperature and air quality were major concerns at all three field stations. At Berlin and Augsburg, cold temperatures were a problem, particularly in the operational areas in Augsburg and the analytical and administrative areas in Berlin. At Kunia, indoor air quality was a problem with mold, dust, and other contaminants visible on interior surfaces. Stuffiness and occasional overheating were problems in confined areas (such as the analytic areas) at all three field stations.

Recommendations

1. Develop, implement, and follow a regular maintenance program, including regular filter cleaning and changing, for HVAC systems in all facilities.

2. Continue to implement the upgrades to Berlin, including the addition of insulation in the analytic areas to raise winter temperatures. Consider similar procedures for Augsburg.

3. Balance the operation of the HVAC systems so that there are not excessive differences in temperatures in the same space. Evaluate the position of equipment relative to air diffusers and orient it to minimize drafts on the person but maximize air flow through equipment.

4. Implement the planned upgrades to the HVAC system at Kunia. If this is not successful in solving the indoor air quality problems, conduct an indoor air quality survey with particular attention to biological and chemical contaminants.

11.1.3 Color of Walls, Carpets, and Furnishings

Recommendation

In planning new spaces and refurbishing old ones, encourage the use of color both on the walls and in the furniture as a means of livening the environment and providing more visual contrasts. Since painting is supposed to be performed periodically, this can be accomplished with little or no added expenditure of resources. Color schemes for all furnishings should be coordinated to provide uniformity, rather than tackiness, however.

11.1.4 Visual interest

Recommendation

Paintings, artificial windows and photographs should be used to alleviate the uniformity of the walls and provide variety and visual interest. The interview and questionnaire data elicited suggestions that talented staff members would welcome the opportunity to paint murals on large surfaces such as the tunnel at Kunia or cafeteria walls. This could be used as some sort of design competition and/or the means to personalize work areas by depicting various operations, armed services, etc. The entrance tunnel at Kunia could provide an "extensive canvas" for many such creative expressions.

Provide sufficient space for desk/wall personalization such as small photos, cartoons, etc to avoid the current sterile environment.

11.1.5 Illumination

Recommendations

1. Fixtures and lamps should be uniform throughout given work areas such as operations, analysis, or administration. Do not mix cool white and warm white fluorescent light sources within a single fixture or room.

2. The stock of replacement lamps should be uniform, to ensure that future changes in lamps do not create the same problems that now exist.

3. Preventive maintenance and cleaning of fixtures and bulbs should be performed regularly. This schedule should be followed to increase fixture life and decrease problems of flicker.

4. Localized lighting controls, both switching and dimming, should be available for all major activity areas. While pull cords are an effective means of control, more elaborate electronic switching systems are now available that would allow both dimming and switching from central or individual locations.

5. Fully adjustable task lighting should be provided for all positions requiring them. The capability of adding lighting for doing maintenance should be provided when equipment is being designed.

6. Use better color rendering light sources such as the "designer" 3500 series now available from several major manufacturers. This would improve the appearance of people, walls and furnishings. Use a better color-rendering light source other than the high pressure sodium now being used in the Kunia tunnel so that people don't look sick.

7. Increase overall illuminance in public areas such as hallways, break areas, and cafeterias beyond the 10-15 lux often available now. Consider the use of wall washing in operational areas-perhaps to illuminate maps and posters - to increase the apparent size of the space and to provide visual interest.

8. Evaluate the effectiveness of some of the new types of fixtures now being marketed for use with VDT's. These include deep cell parabolic fixtures that are intended to reduce glare and reflections from the light source on the screen without reducing light levels below those needed to read paper tasks easily. Where possible, plan the arrangement of the furniture so that the light source does not shine in a person's eyes or on his/her screen. Consider the use of up-lighting in operational areas to direct light up to and off the ceiling to add illuminance to the space without increasing screen reflections and glare.

9. Consider the use of light pipes at Kunia to bring daylight into the dining room. Otherwise, use better color rendering lights in the dining room and perhaps vary illuminance in the space. Consider the use of lighted displays to simulate outdoor scenes, again in the cafeteria or other public area.

11.1.6 Acoustics

Recommendations

1. Whenever possible, isolate major noise sources such as printers, teletypes, ventilators, etc., from the work floor, so that the minimum number of people are disturbed. Locate these in a different room or behind acoustical partitions.

2. Replace noisy equipment, which is usually out-of-date, with quieter, more efficient devices.

3. Initiate a hearing conservation program to:
   a. Determine whether current operator practices have resulted in substantial hearing losses.
   b. Provide additional training to operators as to how to effectively use their equipment. Teach them that turning up the gain does not result in better performance.
   c. Upgrade equipment to enable operators to selectively filter noise, thereby improving the signal/noise ratio and improving job performance.

11.1.7 Space

Recommendations

1. Inventory the equipment on the work floors to identify those items that should be removed.
2. Discard unnecessary equipment.
3. Consider use of space saver desks and work stations. There is clearly a need to think vertically (as long as people can still reach items stored above) rather than horizontally. Using integrated workstations might be a better way of maximizing the limited space available. Evaluate such furniture before procurement to determine its sturdiness, likely durability, and functionality in typical tasks.

11.2 Recommendations - Long term

11.2.1 Maintenance

Headquarters. A good record/retrieval system would be achieved if EMRA could distribute up to date systems operation and repair information on a computer-readable disk (compatible with current systems in use at the field stations), redundant with the manuals now provided to the field stations. A problem with the current system is the lack of feedback information and the time delay between when a part is ordered and received; if a problem occurs, the sequence has to start over again. This process can take months.

Field Stations. Develop a central system at the field stations for ensuring that routine maintenance and repairs are done to the facility as well as to the systems. Develop and adhere to schedules for maintaining the facility, including HVAC, lighting, painting, furniture inspection, and similar routine matters that become important only when neglected.

One person in each major activity (operations, analytic, maintenance, administration) could be made responsible for reporting environmental and design deficiencies; this can be a rotating assignment. Among the responsibilities would be to report on the need to:

1. Change lamps when flickering or burnt out.
2. Identify furniture needing repair or replacement.
3. Clean or paint areas.
4. Deal with the presence of dust, odors (air quality) or other signs of environmental deficiencies.

11.2.2 Systems and Ergonomics

Recommendations

1. Even though early input to the design process by the systems office is important, they become aware of systems in place only after the fact, and then their potential contribution is severely limited.

2. Input from the field and periodic feedback about system performance is essential, but no formal system is in place to provide this kind of information.

3. Operations and maintenance people from the field ought to be used by Headquarters in making design and operational decisions.

4. Authorized representatives of field stations should provide feedback, rather than relying on ad hoc reports.

5. It would seem to make sense for the systems office to work out of the CO's shop rather than S3. In this way, it would be feasible to make the systems office aware of communications and projects assigned to other units.

Field station personnel should participate to the extent possible in writing specifications for systems so that ergonomic and functional aspects of the systems are not ignored.

Develop a system for providing positive feedback to site personnel, particularly operators and analysts. They <u>are</u> informed when something does not go right; let them know when they have done a particularly good job, as well.

Evaluate the consequences of systems that are difficult to learn, use and maintain, in terms of increased errors, lost productivity and increased frustration. Employ traditional means of obtaining human factors and ergonomic data to document inefficiencies in current equipment and systems. These data can demonstrate the costs in terms of mission performance, delays, etc, associated with <u>not</u> changing current procedures. (These methods are currently employed throughout DOD; as a consequence, users do not have to overcome system, hardware and software design flaws to perform their jobs.) At present, although the authors strongly believe that performance in the field stations is degraded by overlooking ergonomic factors in the design installation and use of equipment, objective evidence, or even expert judgments, to support this position, is lacking. Therefore, there is a crying need to evaluate systems from an ergonomic standpoint, demonstrate decreased performance and correct the systems.

11.2.3 Information Center

Recommendations

1. Use the information center to support administrative activities as well as operational and analytic efforts. Ensure that each primary staff member has a terminal.

2. Train appropriate administrative personnel in the requisite computer languages and packages.

3. Standardize hardware and software to the extent possible to increase ease of support and maintenance.

4. Have the administrative and the mission side talk on the same network or system, and increase user awareness of the system capabilities. Network major systems and develop electronic mail capabilities for administrative tasks.

11.2.4 General Recommendations

1. User and designer should work together in testing and getting feedback on system performance before, not after, development when changes are difficult and time consuming. The products would be better, more timely, easier to use, and more likely to be acceptable because of user involvement and input.

2. Initiate pilot programs to evaluate furnishings and systems at some locations; design furnishings, test and then make decisions about general implementation. Also, maintain records of what works and does not. Better documentation is needed about developing information, usage, wear, costs, replacements, maintenance. System and design change records ought to be kept by S4.

3. Breakdowns in communication between operators and analysts occurs in school, with instructors fostering differences; at work, old timers reinforce ideas of separation. Develop procedures for ensuring better communication between different groups to maximize product quality.

11.2.5 Particular Issues

1. Systematic feedback information from the field to Headquarters (HQ). Now the system is largely ad hoc. For example, if a person from a unit is nearby, HQ will often obtain information from the individual, who is likely to have a parochial, rather than a systems viewpoint. Design decisions will continue to be piecemeal if this kind of process is typical. For example, the operator may want to optimize performance of one system component, without being aware of tradeoffs that may adversely affect other parts of the system.

2. The organizational structure today in the battalions makes it difficult to maintain a systems approach.

   a. Each operational battalion has a systems officer, primarily responsive to his commanding officer (CO), rather than to field station system objectives. Decisions are made on a 'local' basis to optimize the performance of a lower echelon unit; such decisions may not have the same consequence for the field station or for completion of overall missions.

   b. Projects coming into the field station are sent to units based on traditional military structure, i.e. intelligence to S2. This practice results in the 'systems office' being unaware of many projects which should be considered from an overall systems basis. The only exception to this is for projects assigned to S3, since the systems office is situated in operations.

11.3 Design Recommendations

The field stations visited appeared to have evolved as a result of mission requirements and the use of technologies as they required. Little facility-wide general planning is evident with regard to office, information, and analytic functions. Given the space constraints in many areas, the use of systems furnishings, designed to accommodate computer terminals and offering vertical storage possibilities, should be given serious consideration.

In upgrading or building new facilities, consider the need to build in flexibility so new systems can be easily implemented and changes readily made with technological advances. Provide extra capacity for data communication, telephones, and power since the work requirements change constantly.

11.4 Fitness Reports

If environmental quality is to be given serious attention, highlighting this topic in evaluations of management personnel through fitness reports or performance evaluations would "send the right signal" to everyone involved.

12. Summary and Conclusions

The present research project was initiated in response to a concern expressed by members of headquarters INSCOM that field station personnel worked under conditions that had adverse consequences on their performance and personal well being. The intent of the study was to gain an understanding of the factors that combine to adversely influence field station personnel, and recommend ways to alleviate problems. One operating premise was that the difficulties cited did not arise from any single dysfunction, but by a combination of them. Of the primary factors believed relevant were environmental conditions (lighting, acoustics, thermal comfort), human factors (man- machine interfaces), furnishings, job design and shift work. (In the past, many specific studies were performed in response to particular problems, but the changes initiated had at best, limited results.)

The study team spent approximately five weeks at several field stations, interviewed tens of people, analyzed questionnaire responses from hundreds, made extensive measurements of conditions at the sites, and carefully observed a host of representative activities. The findings confirm the concerns expressed by headquarters INSCOM; field station personnel perform their jobs under conditions likely to impair their effectiveness. Furthermore, the conditions and circumstances that negatively impact the staff are even more varied than those cited at the start of the study.

The following is a brief review of the major problems areas encountered, with some approaches that might be helpful in alleviating some of them.

12.1 Environmental Issues

The working environments differ in detail from station to station but on the whole have the appearance of being neglected with respect to maintenance and furnishings. Little thought appears to be given to these issues. Ceilings in many locations are noticeable for the variety of lighting fixtures, lack of maintenance and different lamp colors. Desks and chairs show little uniformity and appear to be of ancient vintage in office areas; carpets, when available are often in disrepair and patched together. Temperatures are noticeably uncomfortable in many areas and complaints of being too cold were widespread, particularly at the two sites in Germany. Task lighting was a widespread request, and seldom available. Colors were almost uniformly drab pastels; little variety was evident.

12.2 Equipment and Job Design

Equipment unreliability was a major source of complaint. Considerable skepticism was also evident concerning purported equipment 'upgrades'. Many respondents indicated that 'new and improved' systems were slower,

less responsive and more prone to break down than the systems they replaced. Observations of several activities also indicated that many were extremely difficult to perform. The equipment provided and the sequence of tasks constituted an 'ergonomic horror show'. That is, little thought seems to have been given to designing systems to maximize operator performance, while minimizing the possibility of errors and their consequences. For example one task required operators to look in one direction, stretch in another to initiate control actions and record information. Another required mastery of three different keyboards, as many operating systems and perform these actions in sequence to collect required information.

12.3 General Observations

Personnel find it difficult to sustain their feelings of importance and self worth. The staff of INSCOM are highly qualified and among the most capable of people recruited in the armed services. When their military careers are started, they are convinced their jobs are extremely important. Unfortunately this conviction is being undermined in several ways:

The expectations of people working with high technology systems are that they will work with state-of-the-art equipment. Field systems, especially computer-based ones, are often antiquated. While trained people are aware of the new technology, they are unable to gain experience with it and are frustrated by having to use old devices and obsolete software systems.

The first priority for funding in the past has been for high technology, while environmental conditions which result in complaints, get worse year by year. Promised upgrades and expansions are frequently on 'the drawing board' but seldom get implemented. While waiting for these changes, small scale upgrades are postponed.

The technology at the field stations appears to be imposed on the people rather than being provided <u>for</u> them. That is, while systems and hardware are to be operated and maintained by field station personnel, they have little or no input into their design or configuration. The people have to adapt to the technology, regardless of how difficult it is to operate. Field personnel can make a valuable contribution to the design of such systems, based on their hands-on experiences. Frequently, they are not provided the opportunity for input.

Just as equipment and system users could provide valuable input to writing specifications, those responsible for generating these requirements would greatly benefit by on-site visits to field stations to learn first-hand, how operators perform their jobs, and what problems are encountered using current systems. A wealth of ergonomic information is available, it needs to be applied for improved mission performance.

Furnishings are too frequently hand-me-downs; items that have been in storage for years. This combined with inadequate facility maintenance add to the slipshod appearance of many areas. The message interpreted by many respondents is that 'management doesn't seem to care about the working conditions of the troops'.

While the problem areas identified were categorized in the report for convenience, the most important point to be made is that the individual works under the burden of their cumulative effect. Thus, if we examine particular complaints of poor lighting, ineffective temperature regulation, poor air quality, broken furniture, drab surroundings, unreliable equipment, inadequate space, and high technology systems difficult to operate and maintain, it does not conjure up the image of a good working environment. But the scope of the problem becomes evident when we consider that many people are subject to ALL of these conditions.

One way of comprehending the combined effects of these various factors is to consider them as 'stressors'. In some instances they are readily attributable to tangible sources such as glare on VDT screens and broken furniture, while in other cases the sources are less apparent, and perhaps more fundamental. For example, it was made clear that the cool temperatures found in Berlin and Augsburg, were maintained to ensure that the equipment was suitably cooled. The fact that the staff were uncomfortable and often had to wear jackets and gloves indoors was a "necessary evil". (Data were collected indicating that temperatures in many areas are below those established by ASHRAE (1981) defining comfort conditions.)

This prioritization of equipment over people is reinforced by the faulty facility maintenance, old furnishings, lack of amenities in break areas, and other issues noted previously. It is understood by too many people as a message that undervalues the importance of the individual. In our view, this is the most basic problem encountered, and the one requiring immediate attention.

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Appendix A. Glossary of Terms Used in the Text

The lighting definitions are taken from Chapter 1, Dictionary of Terms, of the IES Reference Handbook (1984) and are indicated by quotes.

Ambient Lighting - "Lighting throughout an area that produces general illumination."

ANSI - American National Standards Institute.

ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers.

Ballast - "A device used with electric discharge lamp to obtain the necessary circuit conditions (voltage, current, and wave form) for starting and operating."

CFM - Cubic Feet Per Minute.

Color Rendering Index - "Measure of the degree of color shift objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source of comparable color temperature."

dBA - A logarithmic measure of sound pressure level, expressed as a ratio between two sound pressures, and weighted by the A weighting factor which adjusts the sound level measurements for variations in the response of the human ear to different frequencies.

Diffuser - "A device to redirect or scatter the light from a source, primarily by the process of diffuse transmission."

Direct Glare - "Glare resulting from high luminances or insufficiently shielded light sources in the field of view."

Disability Glare - "Glare resulting in reduced visual performance and visibility. It is often accompanied by discomfort."

Discomfort Glare - "Glare producing discomfort. It does not necessarily interfere with visual performance or visibility."

EPA - Environmental Protection Agency.

Footcandle, fc - a measurement of illuminance. The SI (Metric) unit is the lux. "The unit of illuminance when the foot is taken as the unit of length. It is the illuminance on a surface one square foot in area on which there is a uniformly distributed flux of one lumen, or the illuminance produced on a surface all points of which are at a distance of one foot from a directionally uniform point source of one candela."

Glare - "The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance and visibility."

HVAC - Heating, ventilating and air conditioning system.

IESNA - Illuminating Engineering Society of North America

Illuminance - "Density of the luminous flux incident on a surface; it is the quotient of the luminous flux by the area of the surface when the latter is uniformly illuminated. In lay terms illuminance is the amount of light falling on a surface. It is measured in Lux or foot candles. A foot candle = 10.76 lux."

INSCOM - U.S. Army Intelligence and Security Command

Louver - "A series of baffles used to shield a source from view at certain angles or absorb unwanted light. The baffles usually are arranged in a geometric pattern."

Luminaire - "A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and to connect the loops to the power supply."

Luminance - "The quotient of the luminous flux at an element of the surface surrounding the point and propagated in directions defined by an elementary cone containing the given direction; by the product of the solid angle of the cone and the area of the orthogonal projection of the element of the surface on a plane perpendicular to the given direction." In lay terms, it is the amount of light reflected from a surface. It is measured in candelas/meter squared - (cd/m^2) or footlamberts. A footlambert = 3.426 cd/m^2.

Luminance Contrast; Contrast - "Relationship between the luminance of an object and its immediate background. It is equal to $(L_1-L_2)/L_1$ where L_1 and L_2 are the luminaire of the background and object, respectively. The form of the equation must be specified."

Luminance Ratio - "Ratio between the luminances of any two areas in the visual field."

NAS - National Academy of Sciences

NBS - National Bureau of Standards

OSHA - Occupational Safety and Health Administration

Quality of Lighting - "Pertains to the distribution of luminance in a visual environment. The term is used in a positive sense and implies

that all luminances contribute favorably to visual performance, visual comfort, ease of seeing, safety and esthetics for the specific visual tasks involved."

Task Ambient Lighting - "A combination of task lighting and ambient lighting within an area such that the general level of ambient lighting is lower than and complementary to the task lighting."

Task Lighting - "Lighting directed to a specific surface or area that provides illumination for visual tasks."

VDT - Video Display Terminals

Appendix B. Transcript of Interviews at the Three Field Stations

B.1 Transcript of Kunia Interviews, April 1987

The following is the transcript of interviews made at the second visit to the Kunia field station. The report by Rubin and Collins (1987) contains transcripts of interviews from an earlier visit.

B.1.1 Interview with Facility Manager

The facility manager discussed the planned air conditioning rehabilitation to include a chilled water loop for each floor (1,2, and 3) and replacement of overhead ceiling type air handler units, some of these were last replaced in 1954. Some floor units in the raised floor areas will also be replaced. The existing duct work will be used since an environmental assessment by army personnel from Japan indicated no aldehydes or similar harmful chemicals in the ducts. The new scheme calls for conditioning the air for the first time since the place was built using a pre-conditioning coil in the intake tunnel. This should help both the relative humidity and the cold temperatures. Now, there is no way to control the reduction in temperature overnight. The air is simply filtered to reduce dust.

At present there is a problem with drafts even with warm temperatures. With the AC rehabilitation, there will be more uniform control of air flow, temperature, and relative humidity, along with cleaner air. Many current problems were attributed to an outdated AC system.

With respect to drafts, in rooms with raised flooring, the floor area is pressurized. The pressurized air ideally is drawn into the equipment racks, and the heat is exhausted out and recirculated. The problem is that equipment racks have their own fans, provided by the manufacturer. When these fans are running, the drafts can be considerable. Attempts to convince the manufacturer's representatives that the fans are not needed have been unsuccessful. They prefer to use fans which draw in warm air from other equipment, blow it through their equipment, and exhaust it out the bottom (often onto people).

Another source of drafts is that holes are cut in the floor for equipment wiring and not closed when the work is completed. For example, there is one room on the third floor with 20 holes.

Heavily loaded racks need separate fans, but there are differences of opinion between the AC person and the rack technician. The latter is often unaware of current AC technology (such as that described above, in which the equipment and AC system work together, instead of in conflict). The technicians are often unfamiliar with the Hawaiian climate with relatively high constant temperatures and humidities. Furthermore, they seem to think if a hole is provided for a fan, a fan must be used.

All floors must be pressurized so air flow can be routed through the equipment as designed. The monitoring must be done by hand, even after the AC upgrade, because of the expense of separate monitoring. The planned upgrade will provide a better way of controlling the air handlers, however. It is more difficult for the AC system to be as flexible as the equipment racks since the building must be modified in some cases.

Changing duct work is not easy. On the third floor 90% of the floor tiles leak air (from the air conditioning), because they are worn out and the rubber stripping is gone. A new floor is needed.

B.1.2 Interviews With Four Operators - Equipment Design Issues

The operators discussed some of the ergonomic design issues involved with various types of equipment used at the field station.

B.1.2.1 Hazeltine Console

The operator listens for a signal with characteristic sound - he tunes it in, then sets the receiver with the keyboard. One problem is that the keyboard is off-center - being placed to the left of the desk area. He's sitting catty corner to it, which makes it difficult to key correctly.

If the wrong key is hit the signal can be lost and the operation must be started again. The major equipment problem is the keyboard placement, which causes errors, fatigue and back strain.of the troops are) and finds that his back hurts sometimes. The chair is not comfortable. There is a bar on the table which is in the way. It is intended to be a footrest but often restricts movement. A printer must be accessed once a signal is found. The operator has to stretch to the side to access controls that can barely be reached from the initial position. The chair can't be moved because it is blocked by equipment. More space is needed also, especially for reference books.

The operator has to change positions to turn on printer. Printer speed must be adjusted by turning knobs, even though it's supposed to adjust automatically. Another problem is that the job entails switching from printer to screen - fast - which is difficult in the cramped space.

In changing settings, a key must be depressed repeatedly, instead of changing automatically until the key is released. Another problem is that one signal is monitored on a scope which doesn't feed into the main display console; this must be adjusted separately, by stretching to the side.

B.1.2.2 Issues Associated with the Double Lancer consoles

When the operator searching for a signal, finds it, he communicates by shouting and brings it up on his receiver. He adjusts the antenna, depresses a button, gets the signal, sits down, starts a recorder, checks the levels, and inputs a tape jack input into a rack. During this time, he must shout because he can't leave his station. The rack contains at least one demodulator that is never used. The operator must kneel to use an audio interface assembly. One on the bottom is never used; it's just part of the rack. A scope on the right side of the workstation is used to monitor the signal which is manually patched into it. He sees it on scope and learns to identify the pattern on the screen. He hits 3 buttons and also has a tuning switch on a demodulator.

Wires are strung over a keyboard. The operator comments that the keyboard itself is excellent. There is a spectrum analyzer for tuning the signal and adjusting frequencies. He does need to stretch to look at one display or another. He may key something in on the right, then turn the chair 180 degrees to see another screen on the left. The chair is wobbly and hard and not enough room on the desk to write.

B.1.2.3 Wideband with teletype

This is a wideband position which examines recorded information. The operator reviews 4-5 tapes for a possible signal. Manual patching is required to obtain signals. There is no automatic display. If something is found, it is written in pencil on paper first, then keyed to a TTY. There is supposed to be a time signal on it, but it's broken so times are entered manually.

The job is very boring. Sometime there are three minutes of signals to be heard in six days of work. Once patched in, the signal must be tuned. The equipment is positioned awkwardly for use; at the side instead of being in front. Numbers are read at an acute angle; it is clearly uncomfortable. Also she has two receivers, one of which doesn't function well. There is a self- test on the demodulator which doesn't work. It is a black box which is not used. The two printers near here are never used; they divide the racks, however.

As for chairs, people have their own preference. The table is too low; she bangs her knee on it. She has a note board that can be used for passing on information to later shifts.

B.1.2.4 Blueprint

The analyst sits at a desk waiting for something to happen. She needs to be able to use paper and pen. When the operators shout at her for things to be checked, she must turn around and move to the terminal. The terminal is several (10-12 ft) away from her desk. A person with a question or something to be checked can also come and use it. As a

result, there is a walkspace behind her. She checks on the question and shouts back or writes down information or may print it. She usually shouts at the operator to get attention. If the person is busy, she'll go over to the screen and record needed information. For unidentified signals, she/they watch screens.

She walks to different positions through the day - once or twice an hour on a slow day, but on other days she can run "her feet off". Every hour to hour and a half, she must go up front to get traffic from one area, about 75-100 meters away. She runs a message service, getting material for herself and for the operators. Her activities involve a printer, terminal, communication, and walking to ensure that operators are performing appropriately.

The lights were formerly dimmer and easier on the eyes, but her desk was illuminated by a hall light. Now she can't read the operator's screens, which appear as a green blur. She could use a desk lamp with dim overhead lighting. As for chairs, she is in her third chair for the day. It's really musical chairs - you have to switch to get a chair that will roll. The operators need one that will tilt back and forth. So many of the chairs are broken.

There is a lot of shouting. She gets hoarse by the end of the day. She also has to change paper/ribbons on at least 2-3 printers and do a lot of housekeeping. There is not nearly enough space for storage, although she is the best supplied in the area. There are major problems when the Scribelet terminals go down. Then everything must be done manually which is very time-consuming. Another problem arises during clean-up, when the printer must be unplugged to plug in the vacuum. Then they get errors on the system upstairs which upsets the staff. Unfortunately, the only plug available is one in the center of the floor, so the problem appears to be unavoidable.

B.2 Transcript of Interviews at Augsburg

B.2.1 Maintenance

A primary activity is reading microfiche; all records are on fiche. Readers are of cheap quality, lighting is poor. When focusing on material, document has to be moved and its easy to get sick to the stomach during this activity. A major task is looking for parts listed in many manuals. Sometimes it is necessary to spend all day using fiche readers.

Other records are in massive manuals, difficult to locate material and make appropriate orders without mistakes. Parts are identified by numbers listed in manuals; one after another must be sequenced to complete a request. Power is 50 and 60 Hz, some systems are mixed with both; i.e. fluorescent is one frequency and the ballast, another.

Private space for individual work and conversations with staff is very difficult to come by.

They painted their space; purchased paints, selected colors and did the work themselves on their own time. The added color made a great difference; it also provided the opportunity to clean up the room.

PCs and WPs are needed to help speed up paper work. There is a good deal of skepticism about electronic data. Hard copy is needed and cannot readily be replaced. Problems are to be certain it has been received and whether it is accurate.

Electronic system if it works is fast, accurate, changes can be made rapidly; everyone can work with the same set of books (not true now; page updates occur frequently). Positive feedback possible with electronic system. Accuracy and time improved also.

Some work locations are at remote sites; breakdown of elevator occurs often; buildings are high. People run up and down to go from work area to sleep/rest area. Phones are 'open' and messages heard throughout the building; sleep is interrupted; most messages are for other people than those being contacted. It is a very stressful job, running makes it more stressful. Performance is degraded from stress, lack of sleep, movement up and down; also likely error increase. The work day extends well beyond 8 hours.

When equipment repair is needed, complex interactions are needed at multiple locations with several people working with limited information and inadequate feedback.

B.2.2 Data Processing

Commanders of operating units decide who gets what. A great deal of variability exists depending on knowledge and inclination of chiefs.

Systems were initially developed for specific purposes; now there is a library of often used programs which are modified. Operational and office information systems are separate entities. Data are occasionally combined when reports are written.

Programs often do not meet user needs. There is not enough dialogue between people developing programs and users. There is an informal network of users but most of the contacts are formal; designated representatives from operating units.

Software change requests are filled out when software is delivered, often only tests are those done afterward, the first time that user input is permitted. Now, if product doesn't work, a request change is made and the product is recycled as before. It can take from 2 to 3 weeks to change.

B.2.3 Information Center

Only data processing people are permitted to write programs; concern that amateurs will mess up system. SQL (structured query language) information system used; it is a menu-driven program, which lends itself to writing required reports. Electronic mail is available; used primarily by managers, many troops are unaware of its existence or how to use it. Training guides are being prepared to facilitate computer use. Training on new products is provided.

The configuration manager is responsible for providing proper space and environment for new equipment and systems. He determines what happens to old equipment, placement of people being displaced by systems.

New equipment and configurations are not human engineered separately or in systems or subsystems. Systems are often not controllable or maintainable by staff; size, sequencing of activities, etc. are major problems. Patch cords are in the way because much equipment is prototype. End users are not included in the process, or configuration people. Often there is a discrepancy between initial information on needs and the delivery of the final product; differences in size, configuration, etc. Initial decisions are often based on faulty information, resulting in problems. Change orders often take from 3 to 4 months to process.

System stack (organization) often is illogical from user or maintenance standpoint. Decisions are made at headquarters with little or no knowledge about use conditions; viewed as a <u>hardware</u> problem instead of man-machine one.

B.2.4 Supply - S4

The procurement system is old; based on line numbers, and authorization of mission equipment. Furniture procurement is based on an authorization guideline with flexibility permitted with regard to colors, configurations.

Systems furniture is possible under a command and control regulation; if this regulation can be expanded to include INSCOM activities, then a 'blanket' system approval exists.

Users make decisions on the basis of furniture catalogs in most instances; these come from GSA schedule; time to get equipment can be from 90 days to a year.

There are problems with carpet tiles; fibers can get into equipment. Quality is important, specifications guided by traffic; cleaning is another problem, dirt is swept and gets into equipment, vacuum is seldom used. The sub floor must be kept clean; a good deal of dirt ends up

there. The new area of 2000 sq ft, with carpet tile is holding up well after several months of use.

Changes are made as a result of complaints; facility engineers are supposed to maintain space. People usually make changes on their own- e.g. installing carpets in unauthorized areas, resulting in possible equipment problems due to faulty carpets quality.

Carpet tiles are easier to maintain and replace than carpets, e.g. spillage of coffee - replace tile, cannot replace entire carpet, results in unsightly mess.

B.2.5 Systems Office

The organization is supposed to provide a common systems viewpoint for operational activities; this includes hardware, software, maintenance and ergonomics. The unit is staffed from operating units, who have people rotate in and out of the activity; with the hope that the systems orientation will be brought to the operating floor by this means.

Problems

A major problem is that "everyone thinks that they know systems", and can make decisions about them - data processing, programming, maintenance. As a consequence a great deal of localized decision making exists, resulting in a variety of 'subsystems' that should work together but are incompatible. This is true for information, data processing, operational, hardware, software, etc.

In several cases, where systems have been replaced, operators indicate that the 'improved' system is much worse than the discarded one . For example, an analog system was replaced by a digital one difficult to use, takes much longer to control and provides little feedback to the operator. As a result, getting the same information takes more time and is much more difficult for the operator to use.

In the present system, modifications require change orders which are very time consuming and costly. Decisions are made on faulty data and then changes are made. There is a better way.

The air force, unlike the Army, relies heavily on user input throughout the process, and they seem to avoid many of the problems encountered in field stations by the Army.

B.2.6 Interview with Operations Officer

Operations officer provides mission management activity for each area. She provides mission oversight, evaluation, guidance and tasking for field station operations. In one case she makes her own decisions; in the second case they are tasked from headquarters. There is much

flexibility with tasking and assigning operators. If they see a change, they can respond to it for up to 72 hours before being redirected. At the field station they have considerable experience in determining importance of different activities. They must use informed judgement as well as use some software as part of the trial and error process.

They have expertise in new hardware systems. The old evaluation systems don't work well, so they have to develop their own approach but do have on-site expertise. They work with programmers on how to develop user input. They use ex-operators as contractors to develop software. Many people are just becoming computer literate so working with the programmers is important.

People should know the task difficulty of requests; they need to work with programmers and the data processing staff. The problems in dealing with data processing is that many are civilians who can program, but don't understand the mission very well. The products don't always meet user needs.

User assist in designing equipment is needed. It was done on one specific system, which hasn't come back yet. They need case studies to demonstrate the problem. Contracting in pieces causes problems. Things don't talk to each other properly as a result. One system works well because an individual saw a problem and tried to solve it. It was cheap, fielded quickly, and works well. It has a narrow focus, however. Broader systems tend to have more problems. Often old systems (which work) are removed when new ones come in. They can't go back to the old ones when the new ones are there. They can't do testing on a new system before installation (to iron out the bugs). It's very frustrating.

As for environmental factors, there are no windows, and it is cold! It is a problem for the whole facility. She doesn't like the carpeted tiles because you can't keep them clean. They look cozier but they are trashed after 6 months. Coffee gets spilled all over. The operators leave their positions, drink coffee, and spill it. The lights are different colors, tubes are missing. Replacing the ceiling is a self-help effort. The field engineer doesn't do replacements (on light bulbs).

The analytical area looks awful. They have created a labyrinthine atmosphere. It reinforces the mentality that each person is responsible for only one area. There's lots of paper because they don't throw things out. They went to great lengths to bring the analysts together to further communication. The analysts then built a wall so you can't walk freely. Mission control was repainted but it's still dark and depressing, particularly on mids. They want to be able to see screens. In some areas troops have dimmed lights to see better. The lack of privacy for supervisory personnel is beginning to be solved. Two supervisors may share an office. There is more office space now for counseling. The analysts now have an area for supervision. Analysts have no privacy. It's a difficult area to work. The terminal locations

have dictated the positioning of the space.

B.2.7 Data Processing

The chief of the Data Processing Division discussed the interface between programming and analysis. The army training for programming is aimed at supporting standard army systems for data acquisition including COBAL, PL-1, and IBM databases. Another difficulty is that people often arrive without clearances and it takes 6-8 months to get them cleared. They are placed on an administrative, non-secure system for limited training. There are two major systems - mission, and administrative support. The operation system is similar so the transfer is somewhat effective. It still takes 4-8 months to "get up to speed". In a three year tour, training and clearances can take up one year. Training is hard to come by in Europe. There are more courses in the US. The contract group, MANTECH, lends continuity and provides an institutional memory in the civilian work force. Some army personnel stay on for as much as 5-7 years.

The application side is traditional. Much time is spent in maintaining software and not much in development. As for dialogue with the user, if the mission needs something, they will send their request to the S-3 who will prioritize it and send it to DPD. DPD will review outstanding requests and priorities and respond. People will be switched around as the priorities change. The MANTECH people communicate better because they often were operators in the military.

In terms of how to make things happen, he encourages more personal interaction. A program is in place to support the user by encouraging direct communication with the targeted DPD representative. Weekly meetings are used to develop quick response capabilities. Mission people are not discouraged from doing their own programming although sometimes their programs are not efficient. This can hurt the overall system performance. They have tried giving operators a somewhat simpler language.

His own vision is of a broader Information Center. He would like to see the information center include administrative activities. Ideally, the individual with a request will go to the Information Center (IC) person who will evaluate how to do the task (the person, the IC, or some mix). This is happening, but not fast enough. The administrative personnel aren't trained in the requisite computer language. For example SASS works much better than COBAL. They are beginning to give PC's to everyone. All PC's go to the IC and then go to the user. They have Lotus 1,2,3 and DBase3, which will eventually perform some of the functions of the IC. They have standardized on software packages; headquarters will furnish software, delivered with the PC's. The copyrighted items can cause a nightmare because they cannot be copied ethically.

Eventually, the plan is to have the administrative and the mission side talk on the same terminal. There is a need to increase user awareness of the system capabilities. They give classes on the system and the languages. He put a GS-5 in charge of operations who has been excellent. The IC now has a great deal of momentum at the field station. They are beginning to network major systems and are developing electronic mail capabilities for administrative tasks. The plan is for each primary staff member to have a terminal.

There are some problems of disk storage. He expects PC's to be connected to the mainframes and with each other. This will take time. The databases are not always available. They are starting to get more timely updates. There is frustration with automation because requests are not always responded to. There is poor feedback to the user who is not told the priority on requests.

Attempts are made to satisfy the three battalions as appropriate. They look for generic problems and solutions - it is better to write one program which satisfies the needs of three users than of only one. Some programs take years to develop. This is sometimes understandable and sometimes not. There is a move to off-the-shelf hardware/software and to take advantage of such systems.

As for the environment, he feels it has improved over the last three years. They have tripled their terminals but need the proper tools to do their work. They have gone to modular furniture to spruce up the area. "One problem is that organizers for the tops of desks don't always fit - you'll find a 4' desk and a 6' organizer for example." They will replace the traditional army desk with workstations and modular furniture and have ordered terminal desks.

B.2.8 The Information Center

Ergonomics are a problem in the work space, commented another speaker. There is a teletype on the other side of the wall that interferes with thoughts and conversations, The sound comes through and over the top of the wall. A work order was submitted to fix it about 6-8 weeks ago, but they had to special order the partitions, which are not a standard size. He's in a temporary room, supposedly for six weeks. So far he's been there 3-4 months with at least another 6 weeks likely. There are no lights at the back of the room. He has a fluorescent task lamp but it makes a lot of noise. It doesn't provide enough light so he brought in another lamp from home. The tables they are working on were ordered 1-2 years ago. They are nice because you can move the keyboard up and down and tilt it. "Still, when I go home at night, I usually have pain across the back of my shoulders. It's probably due to my chair".

It is cramped in the facility but they hope to get an extra 100 sq. ft. when they move. They moved before, to make room for a group requiring more space. They are fortunate to have terminals for each person. They

will also have enough PC's so they can work with the customer with PC problems. The system in IC was two years in development. The programming staff was not sure that they needed an IC. They have now redesigned the editor for the system to be easier and provide better instructions. They have created a menu system that will allow the user to use the system more freely.

There are two mainframes and numerous PC's. At the end of the summer they will get a minicomputer. They publish a quarterly newsletter which they would like to be a monthly one. Its purpose is to announce training courses and general purpose tips for people about various computer packages. The name of their office has been change from DPD to Information Management Office. (Letters to the editor about problems users have might be a good addition to the newsletter.) There is an IC representative person in the 3 operational battalions and two others. There are 5 members whose representatives come to the IC for training for 5 weeks. There are two representatives per battalion. They try to teach as much as possible about the mainframes. DP, Operational system, editor, language, application packages are a challenge, but the people are highly motivated. There are 12-15 packages. They expect the representative to be better than the average user and represent both the IC and the battalion. User written programs vary in size and may be written for battalion and mission. One goal is to get communication open between battalions so they have weekly meetings at which they exchange ideas.

B.2.9 Interview with Analysts

The conversation is with the analysts and the impact of the working environment on them. The speaker comments that when he arrived here 3-1/2 years ago, "the policy was to have only 1 fluorescent bulb/fixture, even though they hold 3 normally. It was really dark in here. We put in extra bulbs and were chastised for daring to put in anything. People were on an energy conservation kick. it was unbelievable! There are two different types - soft white and bright. Most of the fixtures are broken and hard to access. The latch breaks when you try to change the bulbs. You can't get bulbs in and out easily to change them. In the section that's supposed to do it, a work order takes months. He has been there 3-1/2 years and has never seen them come in to do anything, even check them. They're flickering like crazy. He could get stuff if he had the right connections and work order. When he first arrived the ceiling tiles were kind of brown and stained from smoking. The vents were black and the walls were filthy. The tiles were cleaned. The speaker spent three days putting up the walls and did the construction and moving. He wanted to improve the environment. He talked to the Field Engineer, who said it would take 6 mo+ to improve the area and he didn't have time. The FE ordered the ceiling tiles for them to put up, and so his section replaced the tiles. The stripping isn't right, however. They have requested paint for the walls which badly need to be painted. It's against the law to have an extension cord for fire safety reasons. They

have all sorts of different power in the walls - 60 Hz, 50 Hz, 110, 220, etc. He has one terminal connected to an illegal extension cord connected to a broken outlet. It is taped to the floor. The work orders don't work but the supplies request (for ceiling tiles, paint, rollers, brushes) do seem to provide the basics. You need to remember that his is a 24 hour mission so all environmental work takes away from the mission.

When they changed the ceiling tiles in 1984-85, they pulled all the asbestos out. It was difficult to work. People were wearing masks. They took readings but ignored people. It all took about a year. They made a protective bubble, vacuumed out the asbestos. The people guarding the asbestos removal workers wore protective suits. They found that the tiles were impregnated with asbestos and "gook" which falls out into the terminals when changing the tiles. It is a real problem. There are also wires laid on top of the tiles. They run wires to move terminals (which they're not supposed to do) and the wires catch junk on top of the tiles. The fire control system also interferes with the tiles. The outlets in the walls are broken and hanging loose. They don't have covers and there are not enough plugs. They have moved at the direction of the CO several times. The barriers in the rooms cause problems and there aren't adequate outlets in the walls. Since the walls are temporary, they can't meet their needs, yet they are constantly getting more terminals.

There was a power upgrade at the field station but it doesn't get into the individual working areas. The space allocation doesn't match the mission loading so the speaker's area is very crowded. The space is not apportioned properly. The rule of thumb is that if you can acquire space you can in a sort of "lebensraum" type maneuver. He has one 4-drawer safe so he has to use the computer for storing information but that's not up 100% by any means. There are six piles of material on his desk that he'd like to get rid of. Do analysts like clutter (as has been alleged by other non-analysts?) He says no, but they don't have enough storage area for things they need. When you are doing shiftwork, you need to leave a clear trail for the analyst who comes after you.

One real problem is the VIP's who come through for which you have to secure the area and can't do any work. Another problem is the need to stand latrine guard during the six months it took the Germans to rebuild the latrines. You couldn't use the latrine at 9AM because there was only one open. They are short of manpower, yet provide people for guard duty. They had a jackhammer outside on the latrine and the noise was unbelievable. The upgrades to improve condition cause all sorts of problems on a 24-hour mission.

They need to use computers to automate their work. They would like DPD to talk to them without being asked (although they are helpful when asked about problems). The MANTECH people do come to the analytic area and have meetings but DPD doesn't. The interaction stops at the S3 level and doesn't reach the analyst level. Change requests go through too many people.

They estimate that only 30-50% of their time goes into product production between meetings, briefings, and details. The speaker believes that he's only working 30% capacity. Another analyst commented that his section was totally overlooked for 5 years. Then there was a crisis and a new emphasis and they added 5 bodies. Nevertheless, he is the only person not eligible for details; the other 4 people in his shop work mission about 30-40% of the time. About 25% of the time a job is done because people are dedicated. Many people have high levels of personal dedication and some will work double shifts to get a job done. The commander's call overrides product production. They were told they were "soldiers first", analysts second.

"Desks lamps would help me a hell of a lot. I could see better, but there's no place to plug them in". They can't run an extension cord. The computer system has been upgraded by the users feel it's slower and less effective than before the upgrade. It'd be better if they'd spend $400 on a cheap word processor - he could accomplish more.

Ergonomics are a disaster area. There are no manuals for any of the systems in the area so you can't do preventative maintenance (even though it's a requirement to so do). It is very rare to talk to the operator or analyst in the design stage to determine how equipment should work.

As for the environment, the MOD 40 printer in the center of the room is used a lot but is very noisy. They could use a wall around it, or move it. The way the terminals and computers are placed in the center of the aisle, people bump into you. It is difficult to work properly. Space and layout are critical needs. People need computer tables. The speaker can only type for an hour before his wrists start to hurt because his desk is too high. The lighting is "crappy". He could use a movable task light. The positions (computers) are not movable, but should be on wheels. This would allow more flexible working space. Space and organization of space is very important. The operator area is very congested. The floor tiles dip. They need an intercom to talk to each person or an electronic mail system. (There is one but it doesn't work for their terminals). It is a one way communication system. The analysts could be closer together in communication but so could the operators. The different operator job classifications don't talk to each others. They don't use their terminals for talking to each other.

Training is also an issue. The IC is limited. They tend to teach basics rather than apply to the mission. The role of the IC representative is unclear. He has gotten a personal friend to do some things. IC is helpful for classes but not in figuring out how to do day-by-day tasks. You have to do that on your own.

B.3 Transcript of Interviews at Berlin

B.3.1 Information Management Office

The speaker worked in secure environments before and comments about the background music by indicating that people want variety. He understands why there is a controlled environment, but his office has nothing in it to preclude a window. "It's crazy. You go through a 700 mile semi-dark corridor into a room with four metal walls. It's so oppressive!"

He has been in army automation for 18 years. At first he expected to work at the leading edge of automation technology. It was 10-12 years behind other army systems. For example, they are procuring a 4300 series IBM - just been withdrawn from the market. Their latest system uses machines in commercial use 15 years ago. "It takes 15 years to get something in procurement".

As a technician it is frustrating; your ability to progress professionally is retarded. You're not learning. He's the manager for a support system which maintains a database for a particular operations. It summarizes the day's activities and provides specific information. The system is old and often down. When asked why it doesn't work, the speaker notes that:

1) the memory capacity is too small;
2) its ability to support peripheral devices is too small (it can't support enough terminals and enough locations to do the job; and
3) it's such an old piece of hardware that obtaining parts is an "absolute nightmare". If it goes down, you're down for days and weeks rather than hours.

The system doesn't impact directly on the ability to collect information, but the overall impact is unknown. He doesn't know what is missed because he can't review historical logs. There is no comparable data within the field station.

A second speaker provides mission software support. When this system goes down, he hears about it and gets 1/2 hour notification. He must be on site if can't get back up to respond. Scheduled outages are cancelled as a function of the activity of the mission, so preventative maintenance is difficult.

It takes 2-3 months to get people confident enough to do limited things. By and large he relies on on-the-job training. The job requires certain experience, but this system is a very specialized application. There are not many places to send people to get trained.

This system is being re-engineered one piece at a time. They have some state of the art equipment, so they have the problem of trying to mix equipment that's 20 years old with hardware developed last year.

Specialized interfaces are needed. Lengthy training is needed for a person to feel competent; the frustration level gets higher without training. After a while one develops intuition and expertise useful in trouble shooting. It's not something that can be written down and readily passed on to someone else. When asked to estimate the time needed for proficiency, " A perfect example is a big system, for which the contract was let in 1981-82, to be installed in 85. It was finally installed in Dec 86, but they've run into so many problems in trying to integrate technology that it will take almost 1-1/2 years to fix. It's taken more time and effort than originally planned.

In the last 20 years people have learned to build systems that "talk to one another, without jumping through hoops." Another speaker commented that in 18 years he'd never seen that happen. "We have a computer room with projected in to support basically same organization - 15 different computer systems. They are intended to talk together eventually. Right now 1-2 talk to each other. There is a great deal of need for communication. An operator many need information from system Y but system X won't talk to Y so he must find a terminal which supports Y. But there are only five in the station so he must leave the operations area and find it (and someone who knows how to use it)."

To get last year's data, he must run downstairs and get tape loaded (again find someone to help). For example, an analyst writing a report has collected the needed information and is writing a final report; working aids range from hard copy to the computer system. Something is on system Q and P which are connected back to headquarters. To get into the local and headquarters data bases, the next nearest terminal is on another floor, at least a five minute walk. Because it's such a hassle to find a free terminal it often isn't done; and the quality of the final report suffers. Historical data is on tape. To log on, he must talk to a programmer to load a special tape if the data are older than about 45 days. It could take 1-1/2 hours if you're lucky. But the computer specialist is often working on a report. He can't waste 1-1/2 hours looking for the right tape. This destroys concentration (with start up and wind down time) and so the frustration level is higher.

People have to know too many different automation procedures just to access systems; passwords, operational systems, logons, etc. It is impossible to learn all systems. Most master just the main one. It takes an analyst 3-4 months to work the simplest system or 1-2 months to be functional as long as someone is by them.

"I can't count the number of times I've had one of those kids come down from upstairs interested in wanting to know a piece of information, but had no idea how to get it from my system", so he want to a different

system, couldn't find it, then went to a different system and had to find another person. A person who has this experience very frequently just gives up and doesn't try any more. It is a fairly common experience which affects the quality of the work.

Most people come in with a 3 year tour. After 2 months they are functional on the job; 4-5 months later they have mastered the system. About that time they have heard about other systems, and say "I want to see if these others are what I've heard about, and will help me do my job". This individual will start going to other people and asking what can I get from systems P,Q,Y, etc. This lasts for a 3-4 month period. After about 1 year, they've experienced so much frustration that they just quit looking. The best and most motivated people get very frustrated. You find that people who've been here 18 months go back to doing routine tasks. They do only what has to be done. They quit doing anything extra or innovative - just fill out the forms and quit thinking. An individual gets tired of climbing mountains. There are a few exceptional individuals who have persevered and who can get on any system and make it work."

"What would be a good system?" The speaker said "if we had only 1-2 vendors providing operating systems. It doesn't matter who they are. If we just had 1-2 systems to learn instead of alphabet soup it would be a big help." There is also a duplication of effort by operators inputting information. In some cases, the information is put on magnetic tape. "I've always had a hazy idea that operators should only enter data once and that the computer should take care of re-entering data but the few attempts at it have met with very few successes. You've got to make a 20-year old system talk to the new system and integrate all the different machines. Even though there may be compatible hardware there isn't compatible software." It took IBM 5 years to put the main system together but many people have had to work extra hours developing a tremendous amount of source code. There are currently 3 people responsible for maintaining the system but even they can never learn it all. It needs to be interfaced with the old system. "Do we have hardware capability? There is frustration just in getting cables run. Do we have the right I/O interfaces?"

"In generating specifications, many people are working out there. There is no central office. Various project managers are on station but don't have details. People in the states have no idea of what's useful. Lip service is paid - they do site surveys but very few people even at the field station are capable of doing capacity evaluation because they have very little automation background as far as system selection, installation, capacity management are concerned. Also when given a project it's one that somebody else has dreamt up and so the interdependencies and relations get overlooked in INSCOM."

"Systems go out and procurement actions are slow. It may take 1 year in planning, going to procurement, and to the RFP. The person who wins the

contract to build the system at his own facility - that takes another year. So there's a minimum of 2-1/2 years before something shows up on site and so it's obsolete by the time it reaches the site. It's been at least 2-1/2 to 3 years after the idea was initiated. The people who had the idea are gone by then. The momentum that caused thing to happen has built up over 3 years. They bring something in to deal with the problem of 3 years ago, but the problem size has increased. The work load has double or shifted in another direction."

The current system affects the overall productivity and quality of the product. If a person leaves after 3 years for another field station, and sees same system , he could function immediately. He would have 3 years of experience. As it is, people have it only if they request re-assignment to the same field station. The experience won't be useful at other field stations. The logistics systems now all run on Honeywell systems so their people can move from place to place. "Our people are the cream of the crop and are highly motivated and so make the real best of a bad situation. The net effect, however, is that for every field station tour a person is only productive for 2 of the 3 years. In a limited number of instances field stations use the same equipment. This cuts down on the learning curve. There is a need for people to be competent and have on-going training. It is better to learn what the job is and then learn how to use tools. This would allow more time to do the job and get good at it. A good idea would be to develop an army automation MOS within INSCOM, identify people with this MOS and keep them. Train people on both army automation and mission system and not come in and out of it, but stay with it.

The next speaker is an operator who processes verbal information. He controls a tape (supplied by either an on-site tape recorder or a computer) to which he listens, and types information. He uses an equalizer to selectively filter out static. He comments that others don't always use it. He tries not to turn the volume too high. He takes about 5 minutes to adjust the equipment to optimize the voice signal. He has taught himself since he had no training on the equalizer; he believes it to be very effective. It took 10-15 minutes to learn how to use the equalizer. He received one day's of training on the main system, then was on his own. Now he is comfortable with it.

B.3.2 Conversation with Analysts

The speaker reviews the final product; information collected, copied and transcribed. He uses the keyboard and the main screen of the computer system. He examines the content, abstracts highlights, and reports using a standard format. He keys information into the computer; e.g. priorities for raw material. The old machine was faster. He does 10-20 messages every 6 hours and the machine isn't fast enough. The processor is down often; it drops information and locks up. It will destroy information on the screen so they require backups (printouts). He often has to rekey information and reboot once or twice per hour. This happens

frequently. With more traffic there is more strain on the equipment. He falls behind and information is lost. A small message (30 min) may take 1-1/2 hour due to slow system. As a result, updates have to start an hour early.

When the system goes down he must go upstairs to every system he's responsible for (3 subsystems with 200 piece of information) and handwrite material manually to find out what's happening. This can take 1-1/2 hour as opposed to 15 minutes on the computer. When the computer is broken, he can't work. There are 3 backup systems so that he can physically type in on the old mod 40's when the main system is down. He enjoys the new system because he can now write two things at once since he has the split screen function. He finds that two splits are very adequate (although 3 screens might be helpful).

B.3.3 Interviews with Operators

In starting a shift, the operator must check out what's going on and learn about activity. The operator on duty will brief him. They monitor with two receivers - punch buttons, look for pattern fit. He lowers the volume until he can't hear and then raises it. He can talk to people elsewhere with a microphone on his headphone and copy information using a keyboard at the same time. He can do it quickly unless the target is difficult. Usually he can copy and listen at the same time. When asked "Do you turn up the volume to find the signal?" Answer "Naw, that don't help at all - that just increases the noise". He has to use the equipment functions to center the target. This job is all listening. Rather than increase the gain, he uses bandwith filters.

The amount of space is a problem. They have a table with limited room. They also have to work with equipment in the center of the room. When someone hears a noise, he runs over and checks the equipment. The closest person runs over. The team chief is responsible. Somebody else will transcribe his information.

The chair problem at Kunia exists elsewhere. There is a battle of chair changes at shift change. It's a dynamic struggle. The chairs break easily, and the backs come off so that the operators are sitting on a stool with a stub sticking up that jabs them in the back. The last man in gets that chair until it's shuffled off. Are they adjustable? They're supposed to be, but not all work. Parts are frozen, gears are stripped so you can't change the height.

A new speaker comments that new systems are coming on line. Timeliness and duplication of efforts are a real problem. There is often a need to re-enter information in 4-5 places. It's insane to have to rekey in 4 extra places. There are different keyboards, etc. No continuity. Response times vary for each system with 6-10 sec response times 10-20 times an hour. It causes major problems for the operators and introduces the potential for errors, particularly with fatigue and inexperience. An

operation that took 3-5 minutes with the old system would take 29 minutes to process with the new system because of mind-boggling slowness and repetition. Operators spend so much time manipulating the systems that they can't do work. They need to learn data processing. The keyboards are all different. They need 3-4 weeks training to do the job with each new system. Numerous displays are possible yet they need only a small percentage of them. They need some automation to indicate presence of a signal and to return to a previously identified signal.

Problems experienced by operators include response times that are so long they make the equipment unusable. Timing budgets are clearly not met. Two seconds is desirable but they're getting 120 sec with the worst case scenario approaching 30 min. The intention is to automate functions but the effect is duplication and long response times - longer than old system.

People don't talk to each other about the need for system interaction. This is a major problem. There is a need to record lost productivity due to it. Occupant comfort is a big problem on the third floor. Operators are exposed to freezing temperatures. One system with a directed air flow had overheating problems. They tried enclosing the equipment to increase operator comfort but this didn't work because the equipment overheated. They finally put holes in the equipment to keep it from failing. Operators wear field jackets, gloves, sweaters, etc, because of the cold. Many stresses exist due to both equipment and environmental problems.

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10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

In response to concerns expressed by headquarters INSCOM, a detailed evaluation of environmental conditions in U.S. Army field stations was undertaken. In the present report, findings and recommendations are given based on interviews with station personne questionnaire responses from over 600 people in three job types (operator, analyst, and administrative/other), extensive measurements of physical conditions, and careful observations of a host of representative activities. Three field stations were evaluated: Kunia, Augsburg, and Berlin. The findings confirm the concerns expressed by headquarters INSCOM; namely, field station personnel perform their jobs under conditions likely to impair their effectiveness. These include poor thermal, lighting, and acoustic conditions, as well as furnishings such as chairs and desks in very poor repair, equipment that is dysfunctional, and general lack of regular maintenance in the facilities. Suggestions for improving conditions in the facilities are presented.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

Environmental assessment, comfort, glare, lighting, noise, post-occupancy evaluation, temperature, VDT's

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